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Let's Get On With It

The few frontiers left for us to conquer are in the vast field of science, and NOAA is fortunate in the areas of science that its programs encompass. NOAA explores new directions in the environmental sciences, both physical and biological. It uses chemistry, physics, biology, engineering and mathematics for the ultimate good of humankind. It pioneers programs to care for what's healthy about our Earth and cures for what ails it. NOAA is an exciting place to work.

NOAA also seeks to be in the forefront of seeing that this vast science frontier has enough pioneers to carry on the responsibilities of the agency. There is still work to be done in ensuring that all people, regardless of race, color, sex, age, national origin, and physical handicaps, be given equal consideration based on their ability to perform the job.

This summer, as in the two previous summers, I had the pleasure of spending some time lecturing to a group of outstanding high school students at the Marine Science Program for the Handicapped at Wallops Island, sponsored by the National Science Foundation. I lecture there because, besides knowing something about oceanography, data gathering, and the sciences that make up marine science, I also happen to be a role model for the students.

From my wheelchair I tell them of the science jobs that are possible for the blind, deaf, or orthopedically disabled. They are aware that I have accomplished many of my career goals in science. They are also aware of NOAA and the many science jobs that are performed in this agency, and I trust that many of them will become qualified and obtain employment with NOAA.

Attitudinal barriers have long kept many physically disabled from pursuing careers in science. Sometimes it is very difficult for some able-bodied person to believe that a deaf person, one who is blind, or one orthopedically involved can be a success when there is a requirement for courses in chemistry, physics, biology, and other laboratory sciences.

I think all minorities have been and still are struggling with attitudinal barriers. Twenty years of EEO activity, civil rights, and working with the disabled have convinced me that we have come a long way. I would ask all of you to acknowledge progress, to recognize that there have been improvements—job opportunities, changes in lifestyle, income level, freedom of choice, and an increasing degree of equality. However, I would direct your attention to the second part of the cliche—"yes, we have made progress, but we have a long way to go." The second part asks each of us to build on the sacrifices and struggles of those who have achieved results; it asks us to recognize that, although we have come a long way, we still have a long way to go.

Thomas S. Austin

Thomas S. Austin

Physician Training Course Has Life Saving Aim

Better Medical Service For Divers

By ROLAND D. PAINE

Dr. Morgan Wells, head of the NOAA Diving Office, lectures to physicians at seminar; below, NOAA's "Unbender".

The "Unbender" dominates the room. Looking in the door from outside, the first thing a visitor sees is the entrance chamber at one end of the 18-foot-long white cylinder. Inside the room, it is always next to you, its length stretching nearly from wall to wall, its 7-foot diameter allowing a minimum of activity on each side.

Its dials, pipes of varying colors, gauges, viewports, and other appendages form a functional sculpture in high relief. The unmistakable impression it provides is seriousness of purpose. It is a recompression chamber, and it is used to save lives.

On a day in late spring 12 men and one woman sat in folding chairs along one side of the chamber, furrowing their brows and taking notes. An instructor took them through a chalk talk on the mathematics of using various gases at different pressures for breathing inside the chamber. Pocket calculators were consulted, hands raised, questions asked.

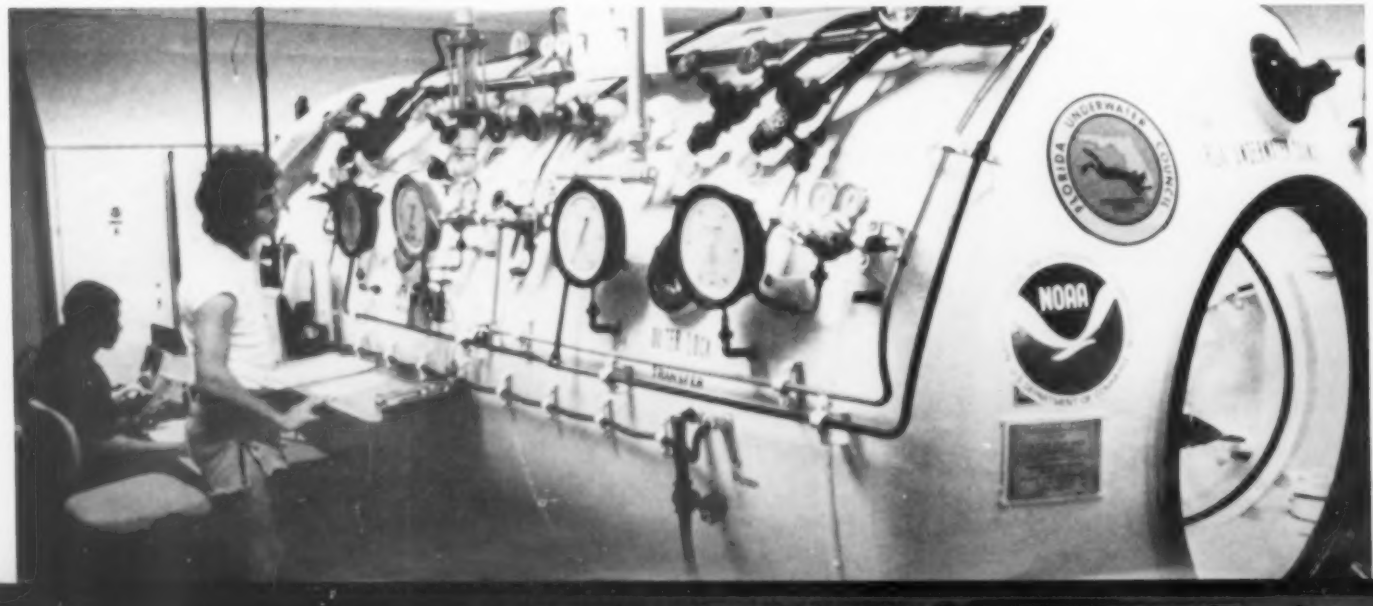
On the other side of the chamber another instructor checked valves and gauges and reviewed a technical bulletin, preparing for the next session, which was practical application using the chamber to demonstrate the principles under discussion.

The 13 students were physicians, embarking on a specialized hyperbaric training program that would teach them how to help divers in trouble. With a zooming population of recreational and Government scuba divers and increased use of divers for commercial work, such as on offshore oil rigs, the number of divers who get caught in risky situation also has increased. So, therefore, has the need for qualified doctors.

Hyperbaric medicine essentially is medical practice conducted under high atmospheric pressure, and it applies principally, though not exclusively, to divers. Many of the problems met by divers are the same as are met by people on land—cuts and bruises, heart attacks, common colds, broken bones, what have you. Some of these problems can be treated just as they are under normal atmospheric pressure, but special attention must be paid to instruments and equipment. Others require alteration in the customary pattern of treatment.

In addition, divers have special problems caused by the greater pressures under water. A diver with scuba gear breathes compressed air regulated to equal the pressure of the water at depth. On descent, the diver's body is pressurized with each breath against the increasing water pressures.

The oxygen in the compressed air is burned off and exhaled in bubbles of carbon dioxide and other gases, which rise to the surface. But nitrogen, which constitutes more than three-quarters of the air mixture, is inert and is dissolved in the blood and body tissues. As the diver moves upward the pressurized air begins to expand with the decreased water pressure. It



A photo sampler of the students and their medical specialties

Dr. Alfred P. Spivack, Palo Alto, California—cardiology.

Dr. Robert Soule, Galveston, Texas—anesthesiology.

Dr. Thomas Chayka, York, Maine—internal and pulmonary medicine.

Dr. Judith Cooper Andersen, Durham, North Carolina—hematology.

Dr. Jerome T. Grismer, Little Rock, Arkansas— thoracic surgery.

Dr. Charles A. Payne, Rio Piedras, Puerto Rico—neurology.

is important for the diver both to ascend slowly and to exhale regularly, so that the dissolved gas in the blood is given time to go into the lungs and be satisfactorily exhaled.

When the gases aren't sufficiently expelled, several problems can arise. The gas may come out of solution and form bubbles that congregate either in bone joints and muscles and cause the painful symptoms known as the "bends," or in the respiratory system and cause the "chokes." The only cure is to return to pressure, preferably breathing oxygen in a recompression chamber, and then ascend more slowly on a recompression treatment table. This permits the gas bubbles to be redissolved and purged from the body.

Another more serious problem is an embolism, when bubbles of air forced into the blood stream rise toward the brain and effectively plug its sources of oxygen and nutrients. Five minutes of oxygen starvation can cause irreversible brain damage; severe cases can end in almost immediate death.

Physicians who work with divers must know the symptoms of each of these special problems, and be prepared to take corrective action in a great hurry. They can also employ a full range of specialties and skills to treat other kinds of medical problems that may occur. Among the physicians taking the NOAA course last spring were specialists in coronary care, neurology, hematology, internal and pulmonary medicine, emergency medicine, and anesthesiology. Some are scuba divers, some not.

One of them, Dr. Robert Soule of Galveston, Tex., had been a diver with the Marine Corps, and later made his living as a commercial diver before deciding, relatively late, to go to medical school. Now beginning his residency in anesthesiology, he intends to specialize in diving medicine.

The need is great. An editor at a prominent oceanographic institution in Miami, not far down the road from the Southeast Fisheries Center where the Unbender is located, commented that she gets phone calls from as far away as Philadelphia from doctors who have patients suffering from one or another dive-related problem, asking for help. Usually it is a bite, scratch, or sting from some unknown sea creature, in which case she refers them to a leading medical expert on the subject; "anything else, I refer them to NOAA."

So, in between lectures on the recompression chamber operations and on the physics and physiology of diving, the students took turns making "dives" in the chamber and operating it under the careful supervision of two instructors, Dr. Morgan Wells, head of the NOAA Diving Office, and Richard Rutkowski, Supervisor of the NOAA/Miami Recompression Facility.

A smaller chamber outside was also used, half the class with it and half with the larger one.

As the week progressed, they dove deeper, were introduced to various mixtures of gases, and began to work with medical equipment and take each other's vital signs in the chamber—pulse, electrocardiagram, blood pressure.

They began to learn the sensations and effects of work under pressure—the high temperature and humidity of a closed chamber, the sudden cooling down when decompression begins, the feeling of being slightly "narc'ed" —experiencing some narcosis from the effects

of nitrogen gas. They learned that their notes on signs, symptoms, and treatments, written while under pressure, often could not be read later on because of the effects of the narcosis—hence, the necessity to report everything to the appropriate people outside the chamber for recording on the official log of the dive.

"It was like having just one or two beers," said Dr. Thomas Chayka, who is in internal and pulmonary medicine at the York (Maine) Hospital. "We began to feel quite cheerful, but fully in control of ourselves and the situation."

Chayka was one whose handwriting actually improved in the chamber—which surely confirms what everyone believes about a doctor's penmanship! But for most, the notes were almost illegible.

A scuba diver himself, Chayka had become interested in the course through a friend who had taken a diving medicine course. The Maine divers have a recompression chamber available in Portsmouth, but find it difficult to get a full team of standby physicians. Chayka is now working with this group, and has also talked to the NOAA diving unit at the Northeast Fisheries Center in Woods Hole, Mass.

Classes did not end at dinnertime. In the evenings the group returned for a variety of projects. On one day, it was a 60-foot chamber dive, with lectures and equipment orientation, and lock-in and lock-out procedures. The Unbender has a separate entrance chamber that can be pressurized separately from the main chamber, so that medical and other personnel can go in and out during the course of a lengthy treatment and recompression.

Problem: how to keep track of the "dive times" of each of these people, so that they can be safely exchanged without impinging on the careful decompression schedule of a patient? The team learned how to do this, and how important it is for the timekeeper to log in every event, so that nothing is overlooked and no one is endangered.

One of Rutkowski's sessions dealt with the organization of the team that operates the chamber. Inside, one patient and one doctor. Outside, the diving supervisor, systems operator, outside physician, and timekeeper. The diving supervisor is in charge, and must be aware of everything that is happening, what recompression tables are in use, what is the condition of patient and other personnel. He makes his decisions in consultation with the physicians, who need to know the capabilities and problems of the equipment and the gases in order to judge the optimum procedure for benefiting the patient. The systems operator, in addition to responding quickly and accurately to the direction of the diving supervisor, must keep note of the gauges and instantly detect any possible equipment problems. The timekeeper has to note down everything so that in case of doubt, the decision chain can be tracked and sound knowledge of the current situation quickly obtained.

All this can be confusing. The need for a well-organized team to keep things under control is brought home forcefully.

Dr. Alfred P. Spivack of Palo Alto, Calif., is a recreational scuba diver who was aware of the importance of such problems, and concerned by the lack of knowledge about diving medicine. He was founder and director (for 10 years) of the Coronary Care Unit at Stanford University Hospital, resigning that position to spend his time in clinical practice with a bit of teaching. As part of the latter, he established a Sports Medicine course, and teaches the diving medicine portion. Having completed the NOAA training, he now has new skills to make available to the burgeoning diving community in his area.

Another evening session was devoted to a lecture by Wells on surface decompression with air, oxygen, and heliox (helium-oxygen mixture) decompression procedures.

A third took place at the nearby waterfront, where the group used various types of surface-supplied equipment—diving helmets where air was provided through hoses from the compressors on the beach, rather that the scuba (self-contained underwater breathing apparatus) gear now in wide use.

One of the nondivers in the group (though she may take it up as a sport) was Dr. Judith Cooper Andersen, head of the hematology laboratories at Duke University Medical Center, Durham, N.C. She was brought into the field through research with the Duke hyperbaric chamber, one of the foremost facilities of its kind in the country. Two things attracted her to the course.

"This is a course where each of us, with our specialties, can work with people in other specialties and learn enough from them and from the course to be really useful," she explained. "Also, it is an area where we can help a patient to become whole again—to come out of the danger as healthy as before. So much of medicine is concerned with just patching up, or with making a person well but less than whole. This work is especially satisfying because of the difference."

The course was the outgrowth of a NOAA-Underwater Medical Society-Navy course that had been run for three sessions, where Wells and Rutkowski gave a week on the chamber, and then the class attended a 3-week Navy diving medicine course. Civilian divers were not admitted to portions of the Navy course, which was designed for Navy physician-divers, so NOAA and the UMS redesigned the NOAA course into a 3-week session for civilian physicians.

NOAA had more than 50 applicants for the course; participants were chosen by a selection committee that looked at such qualifications as medical capabilities, geographic distribution, and potential involvement of the physician with a commercial, Government, or recreational diving community.

In addition to working with the Unbender, the class became acquainted with a small, portable chamber that is designed for use at the scene of a diving operation. The Duocom, as it is called—NOAA now owns two—holds one person seated and another reclining on a stretcher.

A diver who is in trouble and taken aboard ship can be placed in the Duocom and immediately recompressed, where appropriate procedures for returning the victim to surface pressure can be worked out. The Duocom can

The Duocom (above) is a small transportable two-person chamber designed for use at the scene of diving operations; at right, Dr. Wells explains its use to seminar participants.

be transported back to a larger shore-based chamber in the bed of a truck with the diver inside, during those precious moments that otherwise might mean death or permanent injury.

With the class less than a week along in its 3-week session, the varying interests and specialties of the group already were beginning to pay off. Discussions of physiology under varying diving conditions, medical theory applied to diver phenomena, spirited discussions of general conditions and specific situations became commonplace.

What happens in divers, for example, that may suppress their desire to breathe under certain conditions, then trigger it again when it may be too late? What kinds of conditions can cause unconsciousness? How can a doctor recognize what the problem is, or what might have happened, if there is no buddy diver around to provide the information?

Dr. Keith Van Meter of New Orleans is a man attuned to crisis. Emergency medicine is his specialty, and he works in an emergency room coping with all kinds of sudden problems. "Emergency medicine might be called the modern version of general practice," he said, "and more and more of our emergencies are divers. Hyperbaric medicine offers many possibilities, and this course offers much of what I need to know."

Not a neophyte at diving medicine, Van Meter has worked offshore with small chambers and commercial divers, and is acquainted with some of the special problems—such as the pitching and rolling of a deck in a storm—that hyperbaric medicine at sea can encounter.

A full schedule of lectures on Saturday and optional diving, study, or sightseeing on Sunday led to the second week's work, which consisted of lectures, seminars, and tutorials on advanced areas of hyperbaric medicine, given for the most part by research physicians or those with long experience in hyperbaric work. As part of the course the group attended sessions of the Undersea Medical Society, meeting in nearby Key Biscayne.

In addition to lectures, case histories were presented in detail and the physician-students challenged to ask the questions that they as attending physicians would ask, and prescribe the treatments that they thought appropriate.

While most of second week was concentrated academic instruction of medical subjects applied to diving situations, certain demonstrations were included. One was of a rescue of a diving casualty from the water—certainly the initial step in saving a diver in trouble. Like some of the other practical demonstrations, it was important not because it was something that a physician might be expected to do, but because what happens during such rescues is vitally important to the well-being of the diver. The physician must know what procedures were followed, what risks were undertaken, what the rescuers were able to observe about the diver.

Among those who gave the demonstration were Yvonne and Fred Harper of the Florida Underwater Council. The Council focused the efforts of the Miami diving community three years ago on the need for a recompression chamber in the area. NOAA and the Council jointly provided the $150,000 system, whose core is the Unbender, that has saved many lives and that serves as training ground for the physicians hyperbaric training program. Both NOAA and the Council provide support for the facility. Yvonne Harper also serves as volunteer worker with the chamber and as back-up staff for the physicians program.

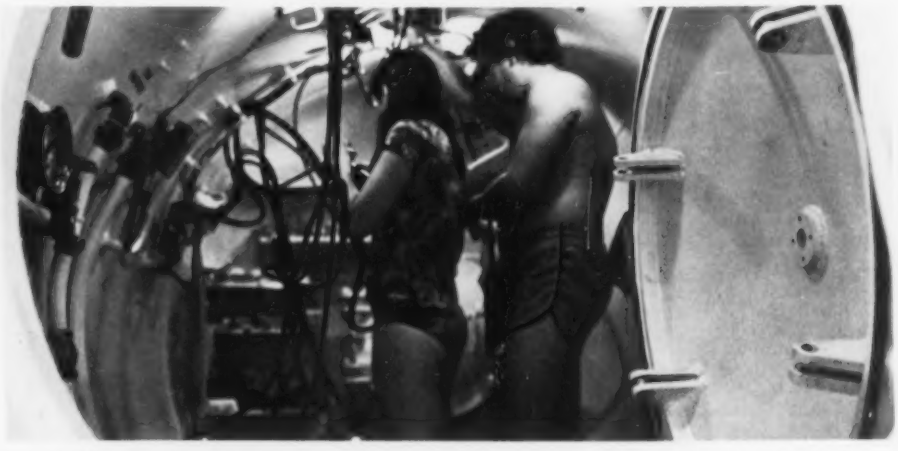
Hyperbaric medicine has uses beyond service to the diving community, and several lectures touched on these. Some bacterial infections, such as gas gangrene and tetanus, are caused by bacteria that cannot survive in the presence of oxygen. Skin grafts can be helped in some cases by the increased oxygen available in a chamber. Dr. Jerome T. Grismer of the Veterans Administration hospital in Little Rock, Ark.—a scuba diver for about 7 years—was particularly interested in the educational possibilities opened up by the course, including possible uses of hyperbaric medicine in various ways throughout Arkansas. He plans to give talks to staffs of Corps of Engineers dams, hospital personnel, and others, to assist them to benefit from skills and knowledge he picked up in Miami.

The second big educational opportunity there is the big scuba community, and he will give talks to dive shop training courses on some of the things he's learned.

The second weekend, like the first, consisted of a full Saturday of lectures and a day off on Sunday. Then back to the NOAA diving facility for additional lectures and practical demonstrations the final week. An orientation course on the University of Miami chamber helped them become familiar with different facilities and systems. Sessions were held on the importance of the diving physical examination, dangerous marine life, autopsy protocol for diving fatalities, the special problems associated with pregnant scuba divers (given by a physician supported by the Texas A&M Sea Grant program), and many other special topics.

And when it was all over, when they had taken their final examinations (half day written, half day practical), when they had their final course review, they scattered—back to their hospitals, their communities, their laboratories. Some of them may be called upon by NOAA. Some will work with commercial divers, some with recreational divers. Anesthesiologist Humberto Beltranena is going to practice in Key West and will work with the new recompression chamber being established there. Dr. Thomas Grimstad, a specialist in pulmonary medicine, will help set up a diving medicine program at his New Orleans hospital. Dr. Charles Payne, the Navy's neurologist in Puerto Rico, is a Reservist who—in addition to his private practice in Rio Piedras—will continue his contacts with the diving community and also expects to help the physician for NOAA's habitat on St. Croix in the Virgin Islands, should the need arise. They and all the others will contribute to better diving safety and to improved medical service to the underwater community.

Which, of course, is what the Unbender is all about. □



Practical work as well as lectures: at nearby waterfront, the physicians worked with various kinds of equipment used by divers (left); they also made several "dives" of varying lengths and depths in the Unbender to learn the procedures and the adaptation of medical requirements to hyperbaric problems.

After 13,000 years, a physical exam

Is Puget Sound?

By JOAN VANDIVER FRISCH

Photo: Seattle King County Convention and Visitors Bureau

At top, the San Juan islands in Puget Sound, where MESA is taking the waterway's "pulse" to determine its health. Below, a purse seiner whose livelihood is closely linked to the quality of water he fishes in.

If your body develops danger signals, you schedule a physical examination. But if a 13,000-year-old reservoir of water, 100 miles long and several hundred feet deep develops danger signals, a comprehensive physical is not an easy task. NOAA's Marine Ecosystems Analysis (MESA) program has begun a comprehensive examination of such a body of water—Puget Sound.

Named for Peter Puget, a young lieutenant with Captain George Vancouver's Northwest Passage expedition, the Sound fills a deep gap between the Douglas fir-covered Cascade Mountains on the east and the rugged, snow-capped Olympics on the west. The natural waterway's basin was formed about 15,000 years ago when a continental glacier, the Puget lobe, flowed down the Strait of Georgia between Vancouver Island the mainland. When the icy lobe blocked what is now the Strait of Juan de Fuca, silt and clay built up in the basin more than 150 feet above present sea level, while the glacier scoured the area. The deep trough developed about 1,500 years later when the glacier began to melt, creating Puget Sound.

Today oceanographers and area ecologists are concerned about the overall health of Puget Sound. They worry if it can withstand the environmental pressures of the industries and the two million people who ring its shores.

To answer these questions, scientists with the Pacific Marine Environmental Laboratory (PMEL) are taking the Sound's watery "pulse" to learn more about its environmental destiny. By monitoring the Sound's tides and currents, they can assess its circulatory system. Results of the study will be used to provide an environmental context for a larger toxic materials study conducted by MESA.

When the project was begun, only isolated water quality symptoms had been reported, explains Dr. Howard Harris, MESA Puget Sound project manager. During the coming five to eight years, the NOAA scientists will study the kinds and degree of environmental impacts, what causes the problem, and what dynamic processes, such as the Sound's circulatory system, influence the impacts. At that time NOAA will be able to recommend possible actions to minimize or eliminate undesirable effects on the Sound's health.

To realize these objectives, PMEL's Dr. Glenn Cannon is conducting water circulation studies of the Sound's currents and tides in the northern half of the Sound. Results of this work, he says, can be applied to solving the specific problem of metropolitan discharge of waste water and other urban effluents that now flow into the bays and inlets from the dozens of communities encircling the waterway.

Elliott Bay, adjacent to Seattle, contains the major sewage outfall for a city of one-half million people. Commencement Bay at Tacoma and Sinclair Inlet near Bremerton have similar outfalls. All discharges have at least primary treatment, which removes a majority of the suspended solids and almost all of the precipitating solids. The NOAA research should help determine whether secondary treatment, which removes more of the suspended and oxygen-demanding material, is an environmental necessity.

One way of assessing this problem is to study the amount of deep water renewal or replacement in Puget Sound. Oceanographers have differing opinions about the amount of renewal that can take place there.

When the fjords of Norway, Greenland, and southeast Alaska emerged, they were carved by glaciation from the head or mountain side toward the mouth or sea. The Puget Sound basin, also etched glacially, developed in the opposite direction—from the mouth to the head. A large continental ice sheet, several hundred feet thick, spread from the north in Canada to the south. In the process, the glacier progressed and receded four times before forming what we now know as Puget Sound.

As a result, according to Cannon, there are some differences in the behavior and health of Puget Sound and the fjords.

A typical fjord, he says, is long, narrow, and always possesses at the mouth an underwater "sill" that was formed by a line of debris. The water is very stratified in temperature or amount of salinity.

"Hood Canal on the Olympic Peninsula is the closest example in Puget Sound of a typical fjord," Cannon said. "All such fjords have snow melts as fresh water sources and have a small surface area, but they are actually very deep, meaning that the real volume of water exchange is very small."

Because the deeper water is so isolated, a fjord-like estuary needs some mechanism, such as coastal upwelling, to flush it out. According to the NOAA oceanographer, that does not happen often. Consequently, the deep water in the estuary most often remains rela-

Photo: Seattle King County Convention and Visitors Bureau

Looming above the three arches of the Pacific Science Center is Mt. Rainier, 60 miles to the southeast of Seattle, where the MESA study is based.

tively still, nutrients stimulate plant production of algae, low oxygen levels result, and water quality problems may develop.

However, results of research during the past two years by Cannon and his colleagues, the late Patrick Laird—recently lost at sea aboard the Holo Holo—and Ted Keefer indicate that Puget Sound has another mechanism to handle the exchange of deep water.

They believe that extremely high tidal currents through the Narrows—a 1-mile long neck of water near Tacoma, Washington, connecting upper and lower Puget Sound—pump deep water up from about twice the depth of the highest underwater point on the seafloor. But they do not know whether this occurs continuously on all incoming tides or only on the largest fortnightly tides.

"In either case the effect of the Narrows is greatly to assist the movement of deep water through Puget Sound," they report.

"Our data indicate that in some instances intermediate and bottom water in the central basin of Puget Sound was replaced in as little as 2 weeks. This is in sharp contrast to the currently accepted replacement time interval of 6 to 12 months."

Implications of the reasearch are particularly relevant to the cities and towns that use Puget Sound as receptacle for human and industrial waste.

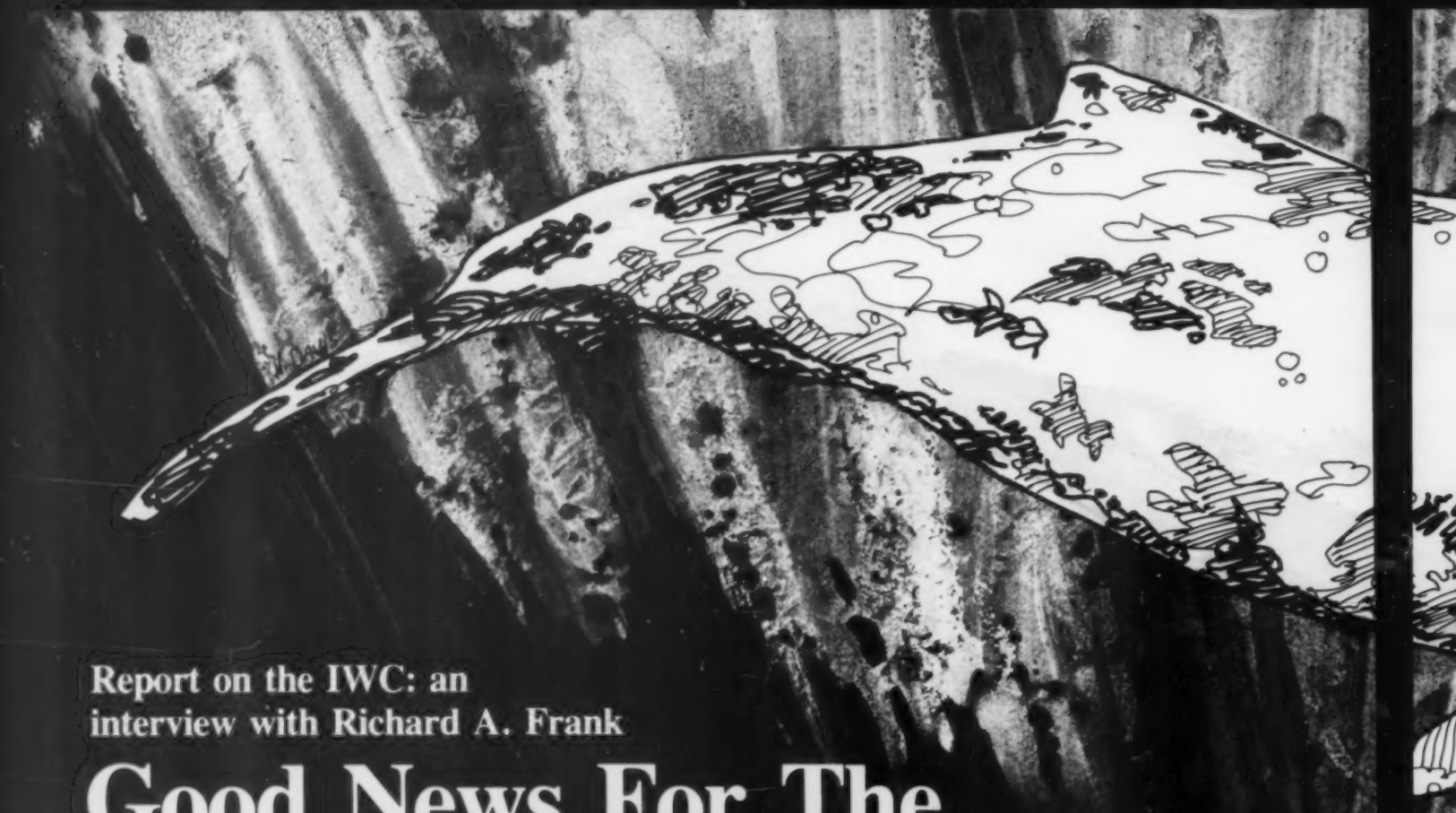
If there is deep water renewal in a fjord-like estuary such as Puget Sound, the water does not become oxygen deficient, and the main basin can accept more organic material, explains Cannon. The shorter the time that the deep water stays in place, the more effluent it can accept. Knowing this time will help such cities as Seattle, Tacoma, Bremerton, and smaller communities decide whether or when they need to go to higher levels of effluent treatment.

Sewer effluent causes problems because it adds organic material to water. This promotes primary plant production, principally algae, in the upper layers of the waterway. Direct input stimulates respiration in deeper water and tends to use up the available oxygen faster than normal. If the deeper water depletes its oxygen supply, hydrogen sulfide forms, so fish and shellfish can't survive. As a result, all free oxygen-using organisms would die or leave the basin. Fortunately, this has not happened yet in Puget Sound.

"There have been a variety of studies of deep water renewal in other fjords in western North America, in Norway, and in the deep ocean in the Carribbean," report Cannon and his colleagues. "None so far show the fortnightly characteristics similar to what has been seen in Puget Sound."

"There is little doubt that numerous important problems affect regional marine ecosystems and that data pertinent to their resolution, such as sewage treatment facilities, would prove valuable to concerned environmental managers and the public," Harris says.

"Ideally, results of the MESA research can be interpreted to predict possible future stress situations within the entire Puget Sound system and other similar systems throughout the world." □



Report on the IWC: an interview with Richard A. Frank

Good News For The World's Whales

The whales of the world have been given a reprieve, and the end of commercial whaling is in sight. This was the good word that came from London earlier this year, following the annual meeting of the International Whaling Commission. NOAA Administrator Richard A. Frank, U.S. member of the Commission, was recently interviewed by NOAA's "Sea and Air" radio show on the IWC actions; this is a transcript of the interview.

Q. *Mr. Frank, what was the prime objective of the United States at the recent meeting and did you meet that objective?*

A. The objective was to put a stop to all commercial whaling. President Carter sent a message to the IWC asking that it ban commercial whaling. We introduced a proposal following the President's recommendation. The IWC did accept part of our proposal and it banned all commercial whaling by factory ships with one small exception. That's very important, because the factory ships are the ones that have led almost to the extinction of the blue whale and the gray whale. So I think we've been very successful. The IWC did other things. It went on to ban all whaling in the Indian Ocean and it systematically reduced quotas. The quotas have been reduced over the last four years now from approximately 45,000 to about 15,000.

Q. *Would you give us more details about this ban on factory ships? Which nations use these vessels and what did the IWC decide about their use?*

A. Factory ships are mainly used by Japan and the Soviet Union. The factory ships can capture and harvest tremendous numbers of whales and that's why they're such a threat. Indeed, in the old days they were the ones that went after the blue whales and did so much destruction to them. What the IWC has said is that factory ships may no longer be used except for one stock of whale, the minke whale, which is plentiful. I think what this really means is that factory ship whaling will simply stop. It isn't economically viable any more and we'll simply not have factory ships.

Q. *A moment ago you mentioned banning whaling in the Indian Ocean. Is it accurate to say that the entire Indian Ocean has been established as a whale sanctuary?*

A. That's right. This is the first whale sanctuary created in 16 years. It's important in itself—that is, there will be no whaling in this area and therefore it can be used for scientific experimentation and the study of whales that are not exploited—and also it may exist as a precedent. What we may be able to do next year and the year thereafter is to get more whale sanctuaries.

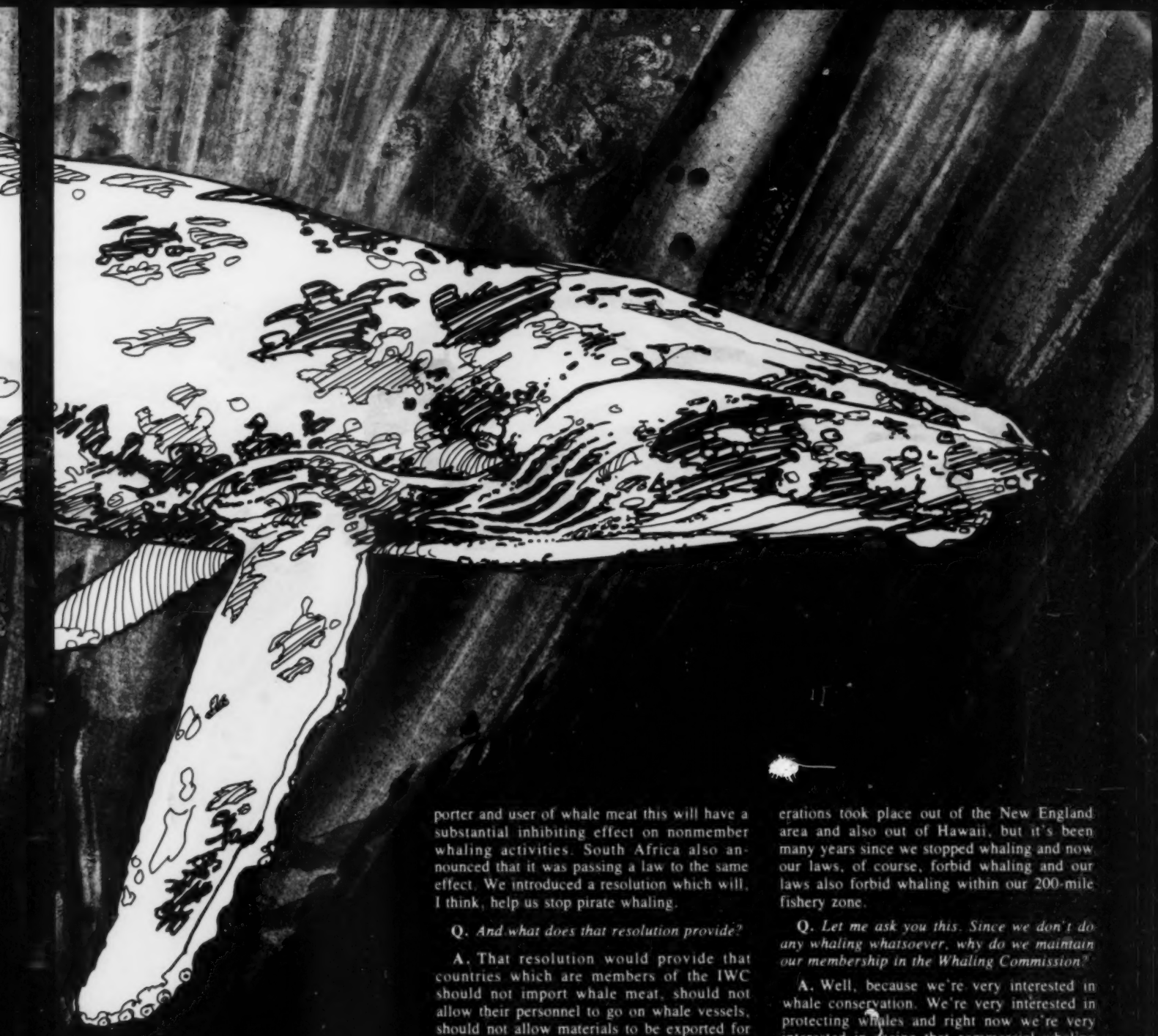
Q. *The United States apparently maintains that the Eskimos in Alaska should be allowed to take a limited number of bowhead whales for their subsistence. Would you tell us about that?*

A. Yes. We have always drawn a distinction between commercial whaling, which has caused all the problems with endangering whales, and subsistence whaling by aboriginal people. Eskimos have been hunting bowhead whales for generations, and they've been living in balance with nature. However, because of commercial whaling the bowhead whale stock has been severely depleted and it is endangered. What we've tried to do is to balance the need of the Eskimos to have whales for cultural and also nutritional purposes with our desire to protect that whale stock. And we think we've done that by regulating the Eskimo whaling but also by giving the Eskimos just a few whales—they're going to get 18 whales next year—and we think that's a small enough number to take care of the stock, but on the other hand a large enough number to allow their culture to continue.

Q. *It does seem like a small number but the whale contributes to their culture in more ways than providing food, does it not?*

A. That's right. It's been an integral part of the culture. It keeps their society together. We've had some studies done by anthropologists on the subject and they point out that the whaling activity itself does more to keep the society together than perhaps any other activity.

Q. *There was considerable reference in the news media during and after the conference to*



"pirate whalers." Would you elaborate on that subject?

A. Pirate whalers are whaling vessels that fly the flags of countries which are not members of the IWC. Now what that means is that those whaling vessels hunt whales without regard to IWC quotas and other IWC regulations. It's bad because that means they exceed the quotas and take numbers of whales which are harmful to the stocks, and in addition they may take whales that are totally banned. The IWC, for example, has banned the taking of blue whales and humpback whales, but pirate whalers will take whatever they come across. Now at the meeting we undertook a number of activities to try to stop pirate whaling. Fortunately, Japan announced that it would no longer import whale meat from nonmember countries, and since Japan is the greatest importer and user of whale meat this will have a substantial inhibiting effect on nonmember whaling activities. South Africa also announced that it was passing a law to the same effect. We introduced a resolution which will, I think, help us stop pirate whaling.

Q. *And what does that resolution provide?*

A. That resolution would provide that countries which are members of the IWC should not import whale meat, should not allow their personnel to go on whale vessels, should not allow materials to be exported for use on those vessels.

Q. *I believe that you mentioned that the nations taking the largest number of whales are Japan and the Soviet Union. Are there other nations still engaged in commercial whaling?*

A. Yes. You are quite right that Japan and the Soviet Union are the countries which catch the most whales, but others are whaling. They include Iceland, Norway, Chile, Peru, Korea, Spain, Brazil, and even some countries, as I pointed out, that are not members of the IWC like Taiwan and Portugal.

Q. *It's been a number of years, has it not, since the United States engaged in whaling of any sort?*

A. That's right. The United States, in the old days, did engage in whaling. Whaling operations took place out of the New England area and also out of Hawaii, but it's been many years since we stopped whaling and now our laws, of course, forbid whaling and our laws also forbid whaling within our 200-mile fishery zone.

Q. *Let me ask you this. Since we don't do any whaling whatsoever, why do we maintain our membership in the Whaling Commission?*

A. Well, because we're very interested in whale conservation. We're very interested in protecting whales and right now we're very interested in seeing that commercial whaling stops. The Whaling Commission is composed of countries which engage in whaling and countries which do not and are interested in conservation of whales. And we're on that side.

Q. *Mr. Frank, are there any success stories dealing with the conservation of whales?*

A. This year's meeting is, I think, the best success story. What we have done through the 31st annual meeting of the IWC is really to start the beginning of the end of whaling, and I expected within three or four years that there will be very little whaling, if any, taking place. The IWC has, in many respects, been very successful over the last few years. Five years ago the quota for whale taking was 45,000. After this year the quota will be down to 15,000. Five years ago or ten years ago

whales such as the blue whale and humpback whale were allowed to be taken. Now the IWC really doesn't allow the taking of any whales which are endangered or at least numbers that would endanger them.

Q. *Does the International Whaling Commission exert any power over nations that do not comply with its regulations?*

A. Well, as with most international organizations, if a country does not comply there isn't much the IWC can do. On the other hand, since 1973 no country has objected to a quota and that means that all member countries are complying. And we will exert whatever pressure we can to continue to see that all countries comply. We have domestic laws which would act against any country that doesn't comply. For example, under the Pelly Amendment, if a country were not to comply with the quota of the IWC we could embargo the import of fish products from that country.

Q. *That ties in with the 200-mile fisheries limit that we have?*

A. No. There is a proposal before Congress now that would make that tie-in. Congress, as you know, also has been very interested in whale conservation and a bill before Congress would now provide that if a country didn't comply with the quota of the IWC that country would lose all or a portion of its rights to fish within our 200-mile zone.

Q. *Would you say that, in the face of the declining quotas set by the Whaling Commission, commercial whaling is going to disappear in the near future?*

A. Yes, I think it will disappear for a number of reasons. First of all international pressure, pressure for example from countries like the United States, is very intense. And I think those countries that engage in whaling like Japan and the Soviet Union are fearful of that pressure. So I think they will stop. In addition the quotas are so low now that there's a question as to whether it will be economically viable to engage in whaling. So I think a combination of public pressure and reduced quotas will result in the end of most whaling within two or three years.

Q. *Playing the devil's advocate for a moment, most people have never even seen a whale in the ocean and probably never will. Given that, what has caused the worldwide interest in whale conservation?*

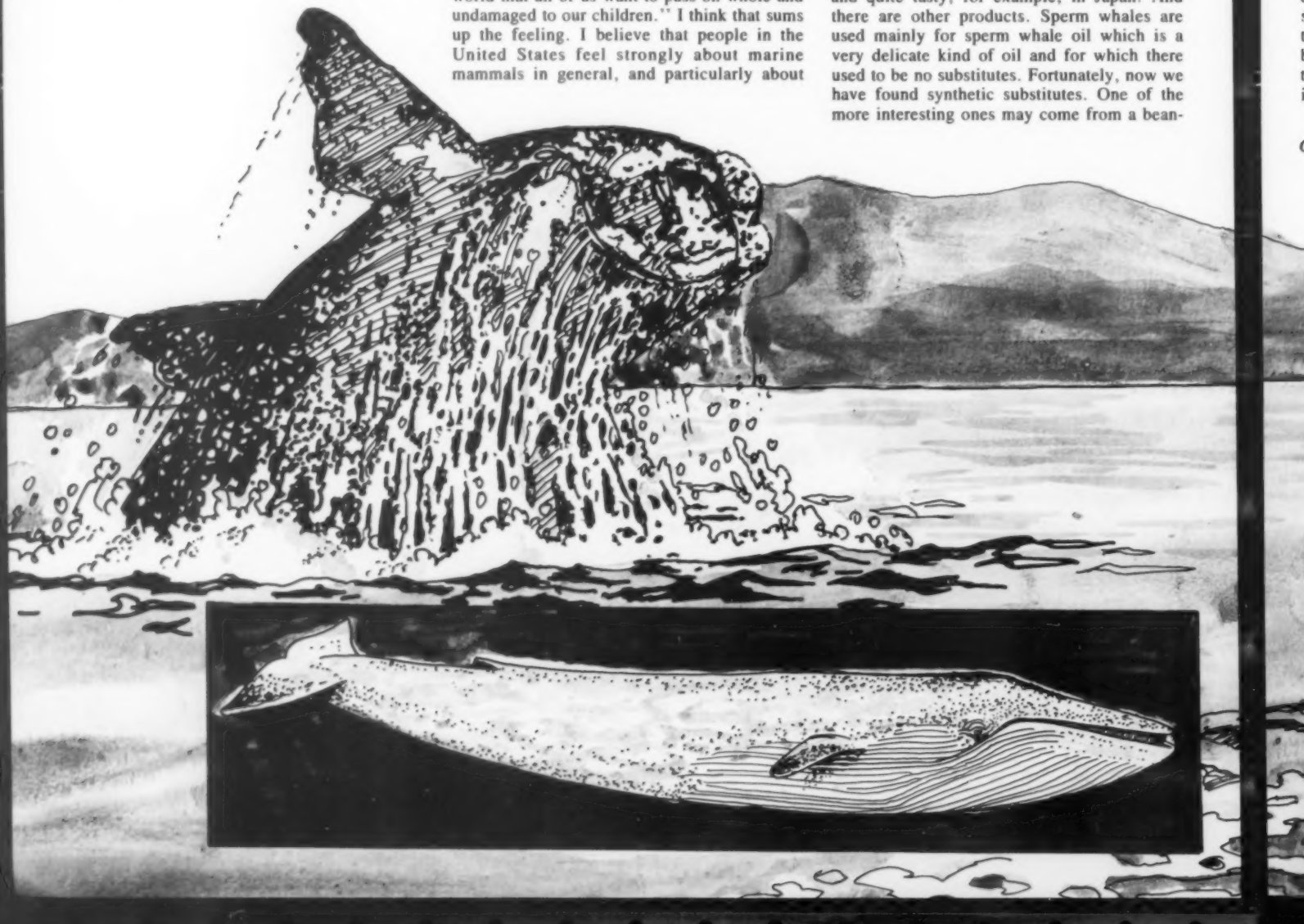
A. I think President Carter put it best when he said in a statement he submitted this year to the IWC, that "whales are a part of the natural world that all of us want to pass on whole and undamaged to our children." I think that sums up the feeling. I believe that people in the United States feel strongly about marine mammals in general, and particularly about whales. We are obviously saddened about what has happened in the slaughter of these magnificent beasts because of greed over the last decades. We want to stop that and we'll work toward the stopping of all whaling.

Q. *Mr. Frank, would you tell us something about the different species of whales. I know that some are larger than others, but can you give us any comparisons?*

A. Well, whales vary quite dramatically. The large whales, the largest whales, are the blue whales, of course. They can grow to more than 100 tons and 100 feet in length. Whales can be as small as a dozen feet long—12 feet long—and maybe 10 tons. Some whales, like the sperm whales, have teeth and will eat other animals. Many whales like the blue whales and the right whales and the bowhead whales don't have teeth. They have something called baleen, which is a bony structure, and they siphon the sea water and small sea animals like krill, which is a small shrimp, through that baleen. And they eat tons of that krill each day.

Q. *Why is whaling so important to some of these nations?*

A. Some countries use some of the whales for meat. Whale meat is thought to be a luxury and quite tasty, for example, in Japan. And there are other products. Sperm whales are used mainly for sperm whale oil which is a very delicate kind of oil and for which there used to be no substitutes. Fortunately, now we have found synthetic substitutes. One of the more interesting ones may come from a bean-



like substance vegetable that's being grown in Mexico at the present time. Whale bone is used for scrimshaw of course, and there are a variety of other products—some of the by-products of whales.

Q. *Are there any whale products that would be severely missed by industry?*

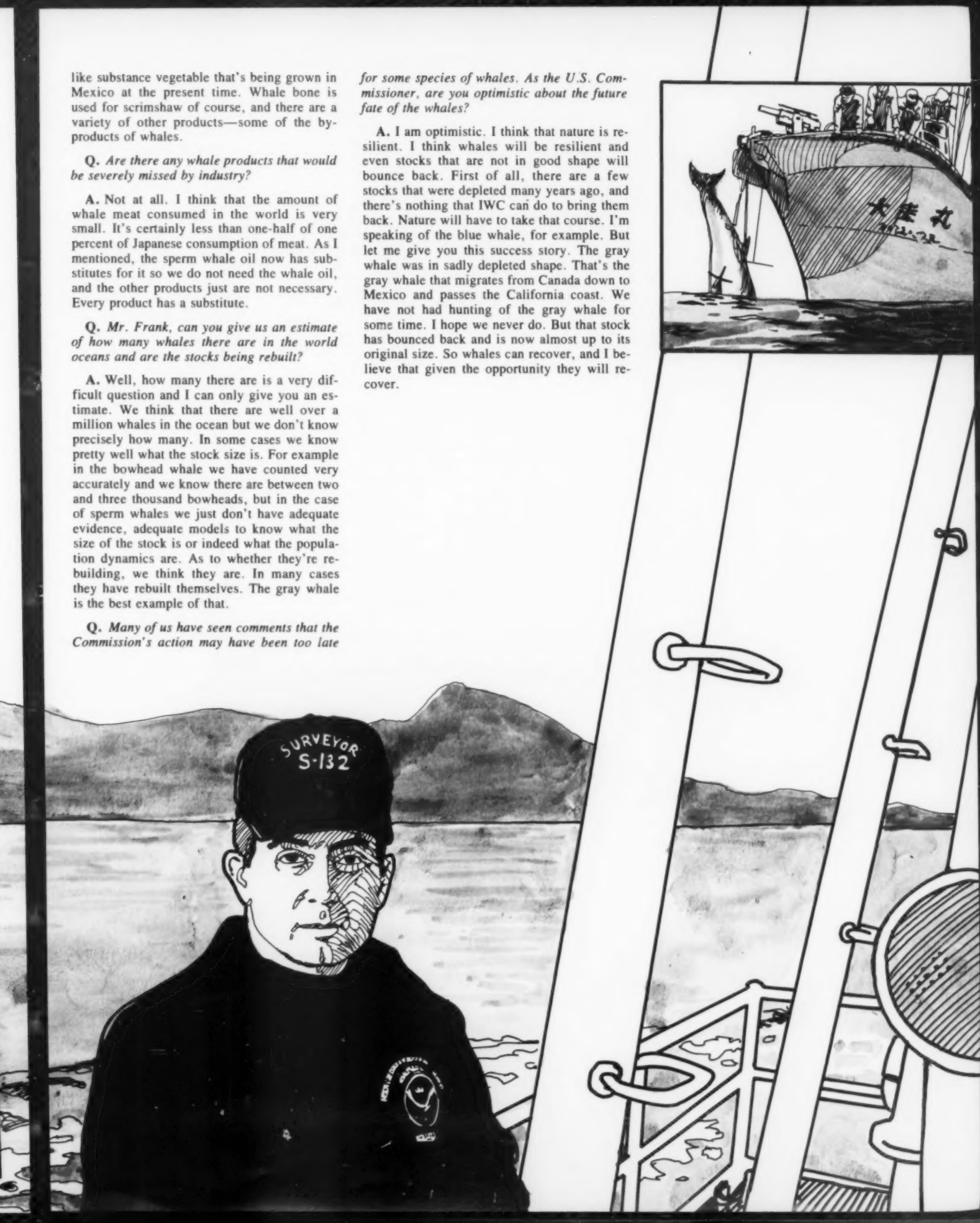
A. Not at all. I think that the amount of whale meat consumed in the world is very small. It's certainly less than one-half of one percent of Japanese consumption of meat. As I mentioned, the sperm whale oil now has substitutes for it so we do not need the whale oil, and the other products just are not necessary. Every product has a substitute.

Q. *Mr. Frank, can you give us an estimate of how many whales there are in the world oceans and are the stocks being rebuilt?*

A. Well, how many there are is a very difficult question and I can only give you an estimate. We think that there are well over a million whales in the ocean but we don't know precisely how many. In some cases we know pretty well what the stock size is. For example in the bowhead whale we have counted very accurately and we know there are between two and three thousand bowheads, but in the case of sperm whales we just don't have adequate evidence, adequate models to know what the size of the stock is or indeed what the population dynamics are. As to whether they're rebuilding, we think they are. In many cases they have rebuilt themselves. The gray whale is the best example of that.

Q. *Many of us have seen comments that the Commission's action may have been too late for some species of whales. As the U.S. Commissioner, are you optimistic about the future fate of the whales?*

A. I am optimistic. I think that nature is resilient. I think whales will be resilient and even stocks that are not in good shape will bounce back. First of all, there are a few stocks that were depleted many years ago, and there's nothing that IWC can do to bring them back. Nature will have to take that course. I'm speaking of the blue whale, for example. But let me give you this success story. The gray whale was in sadly depleted shape. That's the gray whale that migrates from Canada down to Mexico and passes the California coast. We have not had hunting of the gray whale for some time. I hope we never do. But that stock has bounced back and is now almost up to its original size. So whales can recover, and I believe that given the opportunity they will recover.



If you've ever said, "It looks like it's going to rain," you've practiced meteorology and, on a small scale, imitated the National Weather Service's major functions: observing, forecasting, and disseminating weather information.

A number of people, however, are more than just casual observers of the passing weather scene. Many have set up their own stations and gain a great deal of personal satisfaction from recording each day's weather and trying their hand at forecasting.

With some basic instructions and a few simple instruments, some of which can be built at home, one can begin a fascinating hobby as an amateur weather forecaster.

Observing, recording, and *forecasting* are the present, past, and future tenses of meteorology.

Observations, taken accurately and at regular intervals, are of utmost importance to the weather forecaster. Weather changes are not usually heralded definitely by local indications for periods longer than a few hours in advance; indeed many local storms give scarcely an hour's notice of their coming.

Records kept of past weather can be a valuable tool in predicting future weather. The set of rules given later for forecasting weather from local indications is as reliable as any other set of local rules but in many areas they may not apply. To form such rules for any area, the amateur meteorologist must carefully and systematically record and correlate his own observations.

Forecasting is the real challenge of meteorology. Although there has been much exaggeration of the ability of mariners to forecast weather changes from local observations, they are somewhat more adept than people in most other occupations. (Pilots and farmers also acquire some skill at weather forecasting.) This is not because the signs are so much more pronounced over the ocean than over the land, but is primarily because the mariner for many years had no other source of information and of necessity learned to interpret their significance. On land, a heavy storm is not so often a matter of life or death as on the ocean, and consequently, while most people recognize a few signs, they rarely follow them out in a systematic manner to determine their reliability.

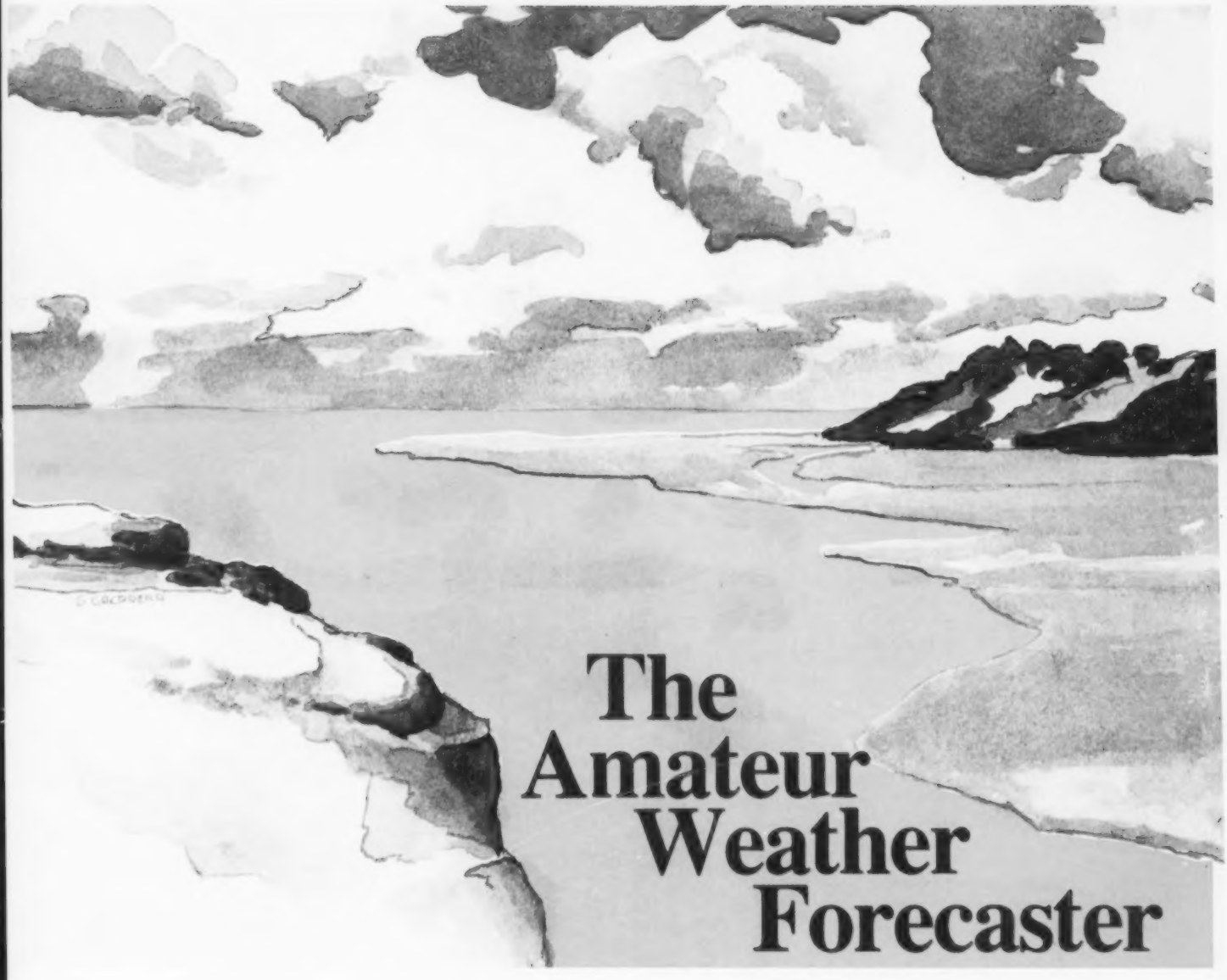
A Weather Log

Don't trust to memory when making a weather observation—write it down. Try to take at least two readings of sky conditions and instruments each day. Additional readings will give an even better picture of changing weather patterns. Three-hourly or six-hourly observations are suitable for most amateur records.

An observer should keep a weather log to record observations. It can be just as simple or just as complete as you want to make it, depending upon the observations to be made.

Here is a brief explanation of the entries to be made in this log. Instruments for observing the weather are discussed later.

Sky: Enter the state of the sky (cloud cover) in tenths or substitute the following symbols:



The Amateur Weather Forecaster

○-clear (less than 1/10); ◑-scattered (2/10 to 5/10); ◑-broken (5/10 to 9/10); ⊕-overcast (more than 9/10). If some form of precipitation is occurring substitute one of the following letters for the sky symbol: R-Rain; S-Snow, H-Hail, T-Thunderstorm; E-Sleet; F-Fog; Z-Freezing Rain; L-Drizzle.

Temperature: Read all thermometers to the nearest whole degree (C or F) and enter current reading. Read the maximum thermometer at the P.M. observation and the minimum thermometer at the A.M. observation. Remember to reset these thermometers after each reading. Figure the day's mean temperature by adding the maximum temperatures and dividing by 2.

Humidity: Read wet and dry bulb thermometers of psychrometer, consult the table, and enter as a whole percentage.

Comparison of the reading on the wet bulb thermometer with those on a dry bulb thermometer will show relative humidity by using this table. Top figures on the chart are the present dry bulb reading. By checking the left column for degree difference shown on the two thermometers and across to the dry bulb reading, the relative humidity can be found. For instance, if the difference between dry and wet bulb thermometers is 6 degrees, and the dry reads 70 degrees, the relative humidity is 72 percent.

Barometer: Read barometer to the nearest hundredth of an inch (or half a millibar*). If the barometer has been rising during the past three hours, mark a plus (+) after the reading entered; if falling, mark a minus (−) after the reading.

Wind: Observe the wind direction to eight points of the compass (N, NE, E, SE, S, SW, W, NW).

Read anemometer or estimate wind speed using the table below. Enter wind direction and speed—for example NE-5 or SW-12.

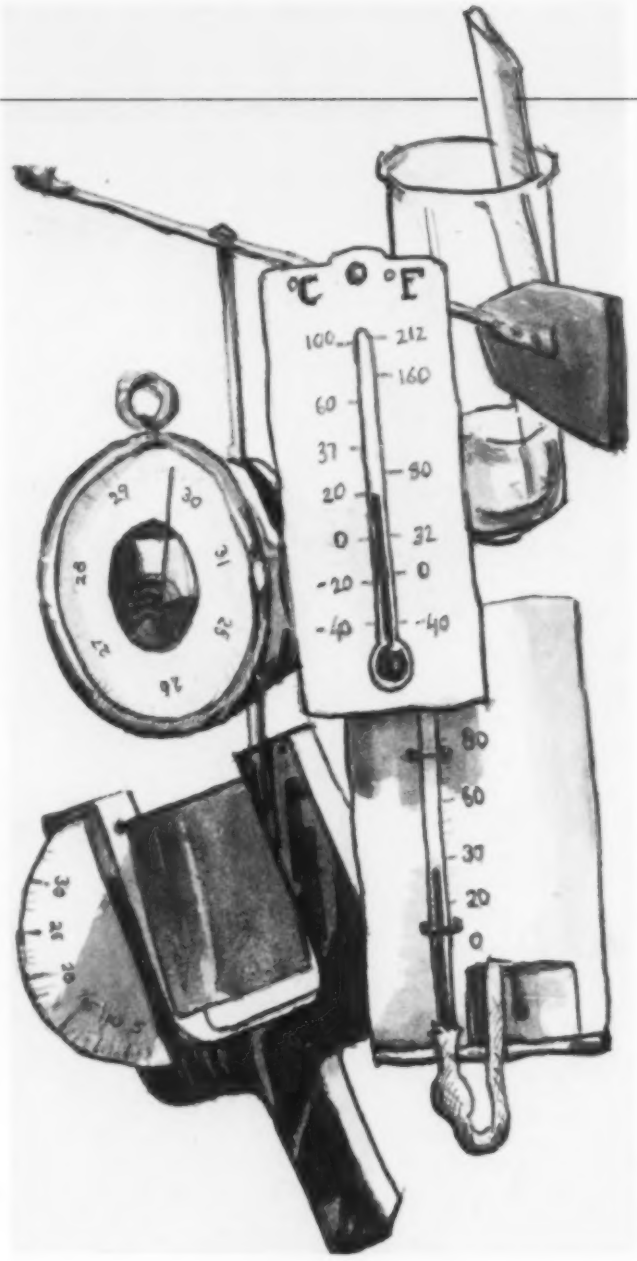
Precipitation: Read gage and enter the amount to the nearest tenth of an inch. If no precipitation has occurred leave column blank. Indicate less than a tenth of an inch by "T" for "Trace." If precipitation is snow take several readings on the ground with a yardstick. Make sure measurements are not made in drifted snow. Average the readings and enter inches followed by the symbol "*". (Generally speaking, 10 inches of snow equals one inch of water but this varies depending on the composition of the snow.)

Be sure to empty the gage after each observation.

Remarks: Enter any special phenomena such as lightning and thunder or smoke or haze and indicate times that the event was observed. Cloud entries may be made here showing type and direction of movement.

** The millibar is a unit of pressure in a universal equal to, roughly, 3 one-hundredths of an inch of mercury.*

Instruments



The amateur's weather station need not be elaborate or expensive; in fact, some of the instruments may be fashioned at home from materials readily at hand and others may be purchased at a nominal cost.

Some of the most common weather instruments include:

Barometer: While the barometer has been greatly overrated as a forecasting device, it is essential that the local observer should be equipped with some means by which to detect changes in atmospheric pressure. Pressure changes used in connection with the wind direction will give the best key to the local situation.

The barometer is—by far—the most expensive instrument the amateur meteorologist may have to purchase. Plans for the construction of "homemade" devices for measuring atmospheric pressure can be found in a number of books on weathercasting, but the skills needed to build them are often beyond the layperson and the instrument's accuracy may be somewhat suspect. In many areas, the telephone company provides recorded forecast and observational information which includes hourly barometer readings. This reading might be used where no other source is available. A serviceable aneroid barometer can be purchased for around $30.

The barometer should not be placed out-of-doors because such exposure may corrode its parts. Since air pressure is the same both indoors and outdoors the instrument can be located inside at some convenient spot. Keep it out of sunlight and away from drafts in a place where the temperature does not vary too much and readings will be reliable.

The barometer should be adjusted to sea level. Instructions for such adjustments will be included with the barometer. The current sea level pressure is available from local Weather Service facilities.

Of the instruments combined in thermometer-barometer-humidity instrument sets, the barometer will be the only aid to the amateur meteorologist. Temperature and humidity readings taken indoors are valueless in forecast work and merely indicate atmospheric conditions within a particular room of the house.

Thermometer: The thermometer is another important weather instrument which can be built by the amateur; but a fairly accurate one can be bought for a few dollars.

If maximum and minimum temperature records are to be kept, a special thermometer (or set of thermometers) will be needed.

The Weather Service uses a set of two thermometers to obtain maximum-minimum readings. The maximum thermometer has a special constriction near the bulb and the minimum thermometer has a floating index. This set costs around $40.

Less expensive is the longtime favorite of amateur forecasters called the Six's-type after its inventor. This U-shaped thermometer—one side reading maximum and one side reading minimum—can be bought for around $16.

A dial-type maximum-minimum thermometer is also available. This type has a coiled metal spring temperature element and two thin metal pointers that are pushed either up or down into position as the main pointer of the temperature element moves around the scale.

Thermometers, of course, should be located outdoors and in constant shade. A properly constructed and situated instrument shelter is ideal for thermometer exposure. Plans for such a shelter are discussed later.

Hygrometer: There are six basically different means of measuring the water vapor content of the atmosphere and hence an equal number of types of hygrometers. The psychrometer type described here is the simplest type of hygrometer and can be built at home without too much trouble.

The psychrometer consists of two matched thermometers—one, exposed to the free air, is the dry bulb and the other has its bulb covered by a water saturated wick, hence the wet bulb. The wet bulb measures the temperature at

which water is evaporating from the wick. Since the rate of evaporation is controlled by the amount of moisture in the air and evaporation is a cooling process, the wet bulb will read lower than the dry bulb. This difference in temperature is known as the wet bulb "depression." When this depression figure is determined by subtracting the wet bulb temperature from the dry bulb temperature, the table in the "Weather Log" section may be consulted to find out the relative humidity.

A simple wet bulb thermometer can be made from a regular thermometer, a bootlace, and a small medicine bottle.

It is best to boil the bootlace before using it to get all the impurities and coloring matter out of it. Use about three inches of a tubular white cotton bootlace. Slip one end of it over the bulb of the thermometer—part of the thermometer's wooden or metal backing may have to be cut off. Arrange the thermometer so that the other end of the bootlace dips into a small bottle filled with water. The water will soak up into the bootlace and keep the bulb moist. The wet bulb thermometer may then be mounted on a suitable backing with another thermometer to form a psychrometer. (Make sure the temperature reading on the two thermometers is the same before they are purchased.)

A factory-built psychrometer, built to Weather Service specifications, can be purchased for around $30.

Hygrometers should be kept out-of-doors in a properly ventilated shelter. In below-freezing temperatures, care should be taken to assure water for the wet bulb is not left outside between readings.

Rain gage: Any straight-sided container may be used for making an inexpensive rain gage. The rainfall for any given period of time is the depth of the rain falling on a horizontal surface during the period considered. If, therefore, the container has straight sides and the same area of cross section as the container opening and is exposed in a horizontal position, the depth of catch measured in inches and tenths may be taken as the correct rainfall value for location.

A #10 can (6-1/16 inches inside diameter, 7 inches tall) will do very well for an improvised rain gage. The can should be exposed in an unsheltered place, and a means provided to keep it level and protected from upsetting in the wind. It would be preferable to have the top edge of the can rolled to reinforce it so it will hold its circular shape.

The depth of water can then be measured by means of a wooden ruler marked in inches and tenths. If a more accurate measurement is desired, the water may be poured from the #10 can into a #303 can which happens to have an area of cross section about one-fourth that of the larger can. Thus the value obtained by measuring the precipitation when poured into the smaller can divided by four will be more accurate than if measured directly in the large can.

An exposure site should be chosen which is a few feet from the ground and well away from buildings and other obstructions. Care should be taken to see that the rain does not splash into the can from the support post or any other nearby object.

Wind vane: Wind direction can be determined from the flow of smoke, the behavior of a flag, or even the time-honored (if somewhat unscientific) wet-finger method. If a wind vane is in sight, so much the better.

A wind vane can easily be fashioned from wood, tin, or other material. Both ends should be balanced and it should swing freely on a central pivot. Ornamental wind vanes may be purchased at small cost adding a decorative value to their scientific usefulness.

The vane should be mounted where the wind is least affected by local influences (trees, buildings, windbreaks), and the direction indicators should be carefully lined up with cardinal compass points.

Anemometer: An anemometer to measure wind speed may be built at home by an amateur craftsman, but such instruments are seldom satisfactory as the gear box of a cup-type anemometer must be thoroughly weatherproofed and the whole instrument is difficult to calibrate in miles per hour.

A hand-held instrument shaped somewhat like a slingshot with a flap suspended between its arms which swings back along a scale as the wind strikes it can be built which will give the observer a fair idea of wind speed. This instrument is calibrated by holding it out of the window of a moving car and marking the point to which the flap is blown back along the scale at different speeds.

As with the wind vane, readings with this instrument should be made where the wind is least affected by local influences. The anemometer, of course, should be headed directly into the wind while a reading is being made.

Instrument shelter: For the best results, the various thermometers listed here (maximum-minimum, psychrometer, and so on) should be kept outdoors, in a shelter. A thermometer really only takes its own temperature, and if this is to represent the air temperature the thermometer must be exposed in such a way that it is subject to the same temperature as the air. This means keeping it out of the sun and keeping it where the air can move freely around it. The best way is to put it in a ventilated box or thermometer shelter.

A simple shelter can be built from a couple of window shutters, some wood or beaver board, and a supporting post or posts. The shutters form the sides of the shelter. The back, top, and bottom can be of ordinary wood. The top should be made from two layers of wood with a small air space in between. It can have a hinged door or an open side, but the opening should face north to keep the sun from shining in and affecting the thermometers when the door is open. The shelter should be painted white, inside and out.

Forecasting

There is no set of rules for forecasting from local indications which will hold good for all areas. Indications along the Pacific Coast differ materially from those along the Atlantic Coast, the Gulf Coast, or the interior of the continent. In the interior there is a great difference between indications in the Rocky Mountain region and the Great Plains or the Great Lakes. Many signs which might be considered reliable in the Ohio Valley would be valueless in the drier regions of the far Southwest.

Weather proverbs will not be found to be generally applicable, and only those which are found to be based upon scientific fact and principles will be worth considering.

Proverbs pertaining to the condition of the atmosphere, the appearance of the sky, the character and movements of the clouds, and the direction and force of the winds are, for the most part, all that are worth testing out for any particular locality.

Proverbs pertaining to the actions of birds and animals are of little value. Changes in the atmospheric conditions may be responsible for their peculiar actions, but they are affected by the weather which is taking place and not by weather to come.

Sayings pertaining to forecasts for coming seasons are entirely without foundation. For example, peculiar growths and developments in vegetation are the results of weather conditions that have passed and have no connection with those to come. The character of the muskrat's house or the beaver's dam is the direct result of the stage of the water at the time the structure was made.

Everything savoring of astrology, or the mysterious in general, should be entirely rejected.

Here are some general statements of wind-barometer indications that are generally applicable to all parts of the country:

"When the wind sets in from points between south and southeast and the barometer falls steadily, a storm is approaching from the west or northwest, and its center will pass near or north of the observer within 12 to 24 hours,

MONTH	SKY		TEMPERATURE					HUMIDITY		BAROMETER		WIND		Precipitation		Remarks
	AM	PM	AM	PM	Max.	Min.	Mean	AM	PM	AM	PM	AM	PM	AM	PM	
1																
2																
3																
4																

with wind shifting to the northwest by way of south and southwest.

"When the wind sets in from points between east and northeast and the barometer falls steadily, a storm is approaching from the south or southwest, and its center will pass near or to the south of the observer within 12 to 24 hours, with winds shifting to northwest by way of north. The rapidity of the storm's approach and its intensity will be indicated by the rate and amount of the fall in the barometer.

"As a rule, winds from the east quadrants and falling barometric pressure indicate foul weather; and winds shifting to the west quadrants indicate clearing and fair weather, but again there are exceptions and in some parts of the country these rules do not apply."

The following table generally summarizes wind and barometer indications in the United States. The amateur forecaster should modify the table in accordance with his or her own observations.

Table of Relative Humidity

Difference between wet-bulb and dry-bulb readings	Temperature of air, dry-bulb thermometer, Fahrenheit							
	30°	40°	50°	60°	70°	80°	90°	100°
1	90	92	93	94	95	96	96	97
2	79	84	87	89	90	92	92	93
3	68	76	80	84	86	87	88	90
4	58	68	74	78	81	83	85	86
6	38	52	61	68	72	75	78	80
8	18	37	49	58	64	68	71	71
10		22	37	48	55	61	65	68
12		8	26	39	48	54	59	62
14			16	30	40	47	53	57
16			5	21	33	41	47	51
18				13	26	35	41	47
20				5	19	29	36	42
22					12	23	32	37
24					6	18	26	33

Wind direction	Barometer reduced to sea level	Character of weather indicated
SW. to NW	30.10 to 30.20 and steady	Fair, with slight temperature changes for 1 to 2 days.
SW. to NW	30.10 to 30.20 and rising rapidly	Fair, followed within 2 days by rain.
SW. to NW	30.20 and above and stationary	Continued fair, with no decided temperature change.
SW. to NW	30.20 and above and falling slowly	Slowly rising temperature and fair for 2 days.
S. to SE	30.10 to 30.20 and falling slowly	Rain within 24 hours.
S. to SE	30.10 to 30.20 and falling rapidly	Wind increasing in force, with rain within 12 to 24 hours.
SE. to NE	30.10 to 30.20 and falling slowly	Rain in 12 to 18 hours.
SE. to NE	30.10 to 30.20 and falling rapidly	Increasing wind, and rain within 12 hours.
E. to NE	30.10 and above and falling slowly	In summer, with light winds, rain may not fall for several days. In winter, rain within 24 hours.
E. to NE	30.10 and above and falling rapidly	In summer, rain probable within 12 to 24 hours. In winter, rain or snow, with increasing winds, will often set in when the barometer begins to fall and the wind sets in from the NE.
SE. to NE	30.00 or below and falling slowly	Rain will continue 1 to 2 days.
SE. to NE	30.00 or below and falling rapidly	Rain, with high wind, followed, within 36 hours, by clearing, and in winter by colder.
S. to SW	30.00 or below and rising slowly	Clearing within a few hours, and fair for several days.
S. to E	29.80 or below and falling rapidly	Severe storm imminent, followed within 24 hours, by clearing, and in winter by colder.
E. to N	29.80 or below and falling rapidly	Severe northeast gale and heavy precipitation; in winter, heavy snow, followed by a cold wave.
Going to W	29.80 or below and rising rapidly	Clearing and colder.

Metric Measurements

The Nation's going metric and one of the leaders in metrication will be the National Weather Service.

Within the next few years, the Weather Service plans to to convert all temperature readings to Celsius. Following shortly thereafter will be the conversion of precipitation measurements from inches to millimeters of rain or centimeters of snow.

To be ready for metrication, the weather amateur should become familiar with the following conversions.

Weather Proverbs

The trouble with weather proverbs is not so much that they're all wrong, but that they're not all right for all times in all places. Some of the ones we hear in New England orginated thousands of years ago in northern Africa near the Mediterranean Sea where they could be heard and repeated and at last recorded by the writers of the Old Testament. And many a farmer in the Middle West, depending on a sure-fire weather saying his grandfather brought from Germany or Sweden has found it useless in the United States.

But distances far shorter than either of these are enough to ruin some weather proverbs—for instance, those that predict rain from the direction of the wind. When the wind blows up the side of a mountain it is cooled and loses its moisture in the form of rain; so that a west wind blowing up the west side of a mountain would produce the same result—a fall of rain—as an east wind blowing up the east side of the same mountain. What this adds up to is that a distance just great enough to hold a good-sized mountain might also be great enough to ruin a proverb about west (or east) winds bringing rain; and people living in Denver should be cautious about wind-and-rain signs that work well for their neighbors over the mountains in Grand Junction, and vice versa. Here are a few, by authors of obvious standing, that were no doubt written in different places.

"Fair weather cometh out of the north."—Job

"The north wind bringeth forth rain."—Proverbs

"Take care not to sow in a north wind or to graft and inoculate when the wind is in the South."—Pliny

"The north wind is best for sowing seed, the south for grafting."—Worledge, 1669

Another point worth noticing about the importance of locality is that on our Pacific Coast the moisture-bearing winds blow in from the west and southwest, while in the East they come from over the Gulf of Mexico and the Atlantic. The two following, then, should not be considered too seriously in the East:

"A western wind carrieth water in his hand";

"When the east wind toucheth it, it shall wither."

On the other hand the one following would have few takers on the west slopes of the Cascade Mountains and the Sierras, where rain and snow are very frequent companions of west and southwest winds:

"When the wind is in the west
the weather is always best."

Also, the south wind, about which it is said

"The south wind warms the aged" and "The south wind is the father of the poor,"

are about the wettest, stormiest, and generally least pleasant of winds in our states bordering the Gulf of Mexico. The proverb writers, including Shakespeare himself, are noticeably consistent in pointing this out—

"The southern wind doth play the trumpet to his purposes, and by his hollow whistling in the leaves foretells a tempest and blustering sky."

"If feet swell, the change will be to the south, and the same thing is a sign of a hurricane."

"When the wind's in the south
The rain's in its mouth."

Anybody who has ever looked at a collection of these sayings must have been impressed by their variety. They are extremely ancient—about as old as language itself; they illustrate as well as anything could illustrate the importance of weather in human affairs; they demonstrate very clearly man's hopeful opinion that experience is a good teacher; their literary merit ranges from excellent to unspeakable; and their range of subject includes practically everything from apple trees to zymology. Also, like politics, which we are told make strange bedfellows, they produce some very striking relationships—wolves and crops, sky colors with foul results, holy days and unholy weather; and rain is foretold by the behavior of cats and dogs and cattle, red hair and ropes, spiders and smoke, crickets, frogs, birds, mice, flies, rheumatism, etc., etc. Squirrel stores and the thickness of their fur make prophesies of hard winters. The drought or wetness of summers is predicted by the weather in March; what happens on Christmas foretells what will happen on Easter; light or heavy fogs in October foretell light or heavy snows in the coming winter; and one proverb says, "If the spring is cold and wet, then the autumn will be hot and dry," another, "A wet fall indicates a cold and early winter," and still another (this one from Holland), "A cow year is a sad year and a bull year is a glad year."

A few others, good, bad, and indifferent, showing this variety of subject:

"When the wind is in the south
It blows the bait in the fishes' mouth."

"One swallow does not make a summer."

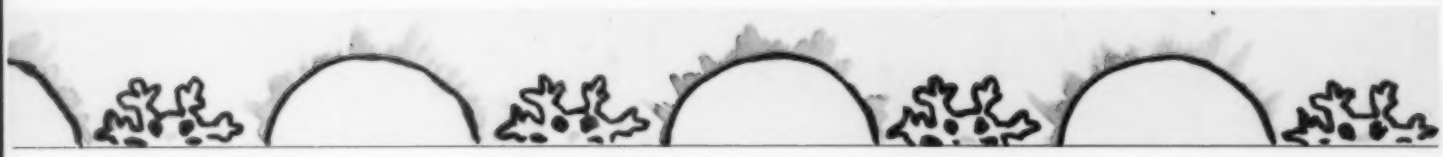
"If the weather is fine, put on your cloak,

Estimating Wind Speeds

This table is based roughly on a scale for estimating wind speeds devised in 1805 by Admiral Sir Francis Beaufort of the British Royal Navy. The original "Beaufort Scale" was based on the effect of various wind speeds on the amount of canvas that a full-rigged frigate of the period could carry. The scale has since been modified and modernized.

Beaufort number	Miles per hour	Knots	International description	Specifications
0	Less than 1	Less than 1	Calm	Calm; smoke rises vertically.
1	1-3	1-3	Light air	Direction of wind shown by smoke drift but not by wind vanes.
2	4-7	4-6	Light breeze	Wind felt on face; leaves rustle; ordinary vane moved by wind.
3	8-12	7-10	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate	Raises dust, loose paper; small branches are moved.
5	19-24	17-21	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	22-27	Strong	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near gale	Whole trees in motion; inconvenience felt walking against wind.
8	39-46	34-40	Gale	Breaks twigs off trees; generally impedes progress.
9	47-54	41-47	Strong gale	Slight structural damage occurs; (chimney pots, slates, removed).
10	55-63	48-55	Storm	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72	56-63	Violent storm	Very rarely experienced; accompanied by widespread damage.
12	73-82	64-71	Hurricane	

By R.E. SPENCER*



If it is wet, do as you please."

"A bad year comes in swimming."

"The first Sunday after Easter settles the weather for the whole summer."

"If Candlemas Day be fair and bright,
Winter will have another flight;
But if Candlemas Day brings clouds and rain,
Winter is gone and won't come again."

"Red sky in the morning, sailors take warning."

"Mare's tails and mackerel scales make tall ships take in their sails."

"March comes in like a lion and goes out like a lamb."

"Clear moon, frost soon."

"Rain before seven, stop by eleven."

"A year of snow, a year of plenty."

"Rainbow in the morning gives you fair warning."

"The bonnie moon is on her back, mend your shoes and sort your thack."

"When the stars begin to huddle, the earth will soon become a puddle."

"A windy May makes a fair year."

"When birds and badgers are fat in October, expect a cold winter."

"Wet May, dry July,
Mud in May, grain in August."

"One would rather see a wolf in February than a peasant in his shirtsleeves."

"February rain is only good to fill ditches."

February rain is as good as manure."

"A warm Christmas, a cold Easter;
A green Christmas, a white Easter."

"The circle of the moon never filled a pond; the circle of the sun wets a shepherd."

"Moonlight nights have the hardest frosts."

"A red morn, that ever yet betokened
Wreck to the seaman, tempest to the field,
Sorrow to shepherds, woe unto the birds,
Gust and foul flaws to herdmen and to herds."

"Do business with men when the wind is in the northwest."

One of the best known of the rain prophesies is the one about the wet 40 days that supposedly follow a rainy St. Swithen's Day (July 15); and the groundhog day story gets into practically every newspaper in the country during the first week in February. Since neither of these old standbys has any basis in fact so far as weather is concerned, their persistent popularity, like that of countless others, must be explained by something else—possibly that nearly everybody on earth, now and for many thousands of years, has wanted to know what the weather is going to be tomorrow, next week, next month, a year from now, and so on. Farmers want to know this and so do sailors because such a large part of their actions and fortunes depend on weather; but it also affects the work of a great variety of other outdoor operators—salesmen, washerwomen, grain speculators, baseball and amusement park managers, brides planning outdoor weddings, fishermen with their eyes on a holiday, military leaders planning field actions, and any number of others, from advertisers to zoo keepers.

Another partial explanation of why these saying are repeated so often is that the repeaters like to speak their wishes or gloomy states of mind, regardless of whether they make logical weather predictions; another, because we love the prestige that comes with prophecy, most of us can't resist the temptation to spout a jingle when it fits the conversation (and even, very often, when it doesn't) like these:

"Fish bite the least
With wind in the east."

"Winter's thunder
Bodes summer's hunger."

"Two full moons in a calendar month bring on a flood."

"A red sun has water in his eye."

Another explanation, also taking account of human vanity and the natural desire to simplify, is that we enjoy the praise of being helpful and the glamor of interpreting mysteries. Here are a few likely examples (if delivered to the right audiences):

"New moon on its back indicates wind; standing on its points indicates rain in summer and snow in winter."

"Mackerel clouds in the sky,
Expect more wet than dry."

"When smoke in clear weather rises vertically, the weather will remain clear."

"When oak trees bend in January good crops may be expected."

But the best explanation for the persistence, the invention, and the very wide distribution of these saying is simply that a great many of them make good sense. For example, the one quoted above about the peasant in his shirtsleeves in February means simply that a warm February will advance the growth of vegetation so far that a subsequent hard frost will destroy it—which nobody wants, especially a farmer who depends on his crops. Here are three other with the same message—

"A late spring never deceives."

"Better to be bitten by a snake than to feel the sun in March."

"A wet March makes a sad harvest."

And "A year of snow is a year of plenty," is just a pleasant way of pointing out that a snowy winter provides enough soil moisture to assure good crops.

The familiar halo of the sun or moon is caused by the refraction of its light by ice-crystals in cirrus clouds, which frequently appear when lowered air pressure and high clouds are present and rain is approaching. Thus, proverbs saying the ring around the sun (or moon) is a sign of rain, such as this one—"The moon with a circle brings water in her beak"—are frequently right.

Several of the many signs men see in the behavior of animals and insects are worth note too. For example:

"A bee was never caught in a shower."

"Expect stormy weather when ants travel in lines, and fair weather when they scatter."

"When flies congregate in swarms, rain follows soon."

"Pigeons return home unusually early before rain."

The following rather inclusive one, giving several results of low air pressure or high humidity (which often precede rain) should prove, if we wait long enough, that not all weather signs are wrong.

"Lamp wicks crackle, candles burn dim, soot falls down, smoke descends, walls and pavements are damp, and disagreeable odors arise from ditches and gutters before rain."

And finally this one, of dubious meteorological value, requires no comment—

"Dirty days hath September
April, June, and November;
From January up to May
The rain it raineth every day.
All the rest have thirty-one
Without a blessed gleam of sun;
And if any of them had two and thirty,
They'd be just as wet and twice as dirty."

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* *"Weather Proverbs" by R.E. Spencer, formerly of the National Weather Service, first appeared in the December 27, 1954, issue of the "Weekly Weather and Crop Bulletin." Several proverbs have been added by the editors.*

Oceanography for the handicapped

Opening Doors To A New Career

By NORMA VALLES REYES

Helen Keller (above) discusses the day's field trip with her husbnd, Dr. Ed Keller.

Dr. Austin (below) shows Robbin Barron a NOAA seal in braille.

Ernest Starcher (below right), coordinator for the blind, shows Charlene Smyth how to hold a small crab.

The old army surplus bus slowly made its way over deep ruts in the road. Behind it followed a small caravan of vans and station wagons, each keeping far enough behind the vehicle in front to avoid the dust clouds it kicked up.

At the dunes where they alighted, their NASA badges securely in place, the passengers sprayed themselves and each other with insect repellent, assembled wheelchairs and helped the owners into them, gathered tools and made their way to the beach.

The Marine Science School for the Handicapped at Wallops Island, Va., was on a field trip. The 22 students and 8 staff members from Oregon to Nova Scotia and Georgia were participating in a 5½ week program that had been created as a gamble 3 years before.

In 1976, Dr. Edward Keller responded to a request from a Congressional committee on Science and Technology for information on National Science Foundation programs for the handicapped. When he learned that money was to be given to NSF for supporting programs for the handicapped he submitted his proposal and was accepted.

On the beach Keller, director of the Marine Science Program for the Handicapped and biology teacher at West Virginia University, directed the movements of his staff and students from the sidelines, using his crutches occasionally to point to an errant crab that had escaped the net. "If we keep track of the animals we bring out of the water, we can put them all back safely, except for those you put in the buckets to take back to the lab," he reminded them.

He watched as Mary Frederick, teacher at the Gallaudet College Model Secondary School for the Deaf, in Washington, D.C., teamed up a deaf student with a blind student to handle one side of the net in the ocean. With the other team of deaf students, they brought to shore a net full of sea lettuce, nonpoisonous jellyfish, anchovies, and a horseshoe crab. Frederick lifted each item and passed it around explaining each one in spoken as well as sign language. Everyone got to touch.

Ernie Starcher, science teacher at the West Virginia School for the Blind, and the coordinator for the blind at the Wallops program, encouraged Robbin Barron of Montgomery, W. Va., to touch the jellyfish. Her reaction was typical of that of many teenage girls, "Yeecht!"

The primary purpose of the program—which is currently one-of-a-kind in the country and possibly the world—is to offer outstanding handicapped high school students precollege exposure and experience in the various areas of marine science and to expose them to practicing oceanographers like Dr. Thomas S. Austin, recently retired director of NOAA's Environmental Data and Information Service. It is conducted in the field station of the Marine Science Consortium, Inc., which includes 17 colleges and universities from West Virginia, Pennsylvania, Maryland, and Washington, D.C.

Austin, himself a paraplegic, lectured to the students from his wheelchair, pointing out various scientific tasks they can perform in spite of their various handicaps.

Paul Cunningham signed for Austin as he does for other instructors who have not been trained to sign. A science teacher at Gallaudet College Model Secondary School for the Deaf, Cunningham is also an instructor and signer at the Marine Science School for the Handicapped. Because of a lack of signs for many scientific terms, he is currently working

on a glossary that will help fill the need.

The students attending this summer's program represented three major physical impairments: blindness, deafness and orthopedically disabled. The success of the program is evident by the enthusiasm with which the students approach their projects in the lab and on field trips and by the fact that only one student did not finish the session this year.

The facilities on Wallops Island were once barracks for the Chincoteague air base and are located next to a NASA flight center and NOAA field station. Cooperation from these facilities and local fishermen and organizations allows Keller's staff to plan field trips to the Government-owned beaches of North Wallops and Assateague Islands and to go on boats whether on field trips or on a pleasure-fishing outing.

For some of the students, the chance to be in the program was a chance to make career decisions. Mark Pietrusinski of Monroeville, Pa., used the experience to help him decide how much science to pursue. "Like Dr. Austin said, you need a lot of science," he said as he made his way with the help of his cane to a pond behind the dunes to gather water for his project testing the salinity of local water sources.

Each student, with the advice of a counselor, selected a main project to complete by the end of the 5 weeks.

Carroll Haller of Newport, Oreg., sat in her wheelchair counting the snails working their way up the tall marsh grass in a basin in her room and recording the tides according to a chart. For her, coming to the school was the first time away from home alone and the first time on a plane. But there is little sign of homesickness. "I would like to find out more, stay for a longer period of time," said Carroll, who will be a freshman at college this fall. "I like it here. I've never been this close to nature."

For the worried parents who don't know how their children will manage, Helen Keller, licensed practical nurse and instructional coordinator for the program tells them, "Don't worry. We're one family. We do everything together."

And they do. They take care of each other. It was not unusual to see Charlene Smyth of Morgantown, W. Va., who is blind, pushing Carroll's wheelchair to the cafeteria when no one else was around to help.

For some of the students, the program fills a void in their quest for information, often limited for them because of their handicaps.

James Krpan, a deaf student from a rural community near Kansas City, Mo., has an interest in marine science that causes him to walk miles from his rural home to a college in the city to get answers to his questions. For such a student the Marine Science Program for the Handicapped is an invaluable opportunity.

"The main thing in a group like this (high school students) is to instill a love of nature," says Jim Koehler, wildlife resources specialist who had his first experience with the handicapped program this year. "If they get this, they will get all the hard facts in college later."

According to Director Keller, almost all of the students who have participated in the program during its first two years are going to college. "When a counselor tells a handicapped student that he can't be an oceanographer and that student has seen Dr. Austin and knows he's been an oceanographer for 33 years and he's in a wheelchair and the student's in a wheelchair, well, 'if Dr. Austin's an oceanographer and he's in a wheelchair, why can't I be an oceanographer?' And of course the answer is, he can."

The biggest problem—besides the lack of sufficient funds to do things the NSF grant does not cover, like administrative support, more printed and braille materials and better vehicles—the biggest problem is the prejudged ideas of what handicapped people can do.

And certainly at Wallops, at the NSF Marine Science Program for the Handicapped where snow fences laid flat help the wheelchairs get into the marshes, where blind students learn to hold crabs so they don't pinch, and where deaf students learn a scientific vocabulary that doesn't exist in their signs, certainly here, no one has any prejudged ideas of what they can do. □

Jim Koehler explains how to remove a stubborn crab from the net. Visitor John Haberlin, NOAA Coordinator for the Handicapped (standing left) watches.

Tod Groves (in chair), Amherst, Ohio, (above) studies sea gulls with help from his friends.

Launa Fields, Demarest, N.J., (top) listens carefully and reads Jim Koehler's lips as he explains about the ghost crab dug up by Jeff Von Nostrand (center) of Potomac, Md.

"The Hell I Can't!"

A Profile of Thomas S. Austin

By PATRICK HUGHES

At Tommy Austin's retirement dinner on June 28, 1979, Bruce MacGill, a member of his staff, presented him with a personal flag proclaiming: "The Hell I Can't." The words capture the essence of the man.

Tommy Austin is one of the most stimulating people you are ever likely to meet. His enthusiasm is contagious, and he has an exceptional ability to motivate those who work with him. As NOAA Administrator Richard A. Frank put it at the retirement ceremonies, "Tommy Austin is an event-making person."

When he left the Government after more than 33 years of distinguished public service, Austin was Director of NOAA's Environmental Data and Information Service (EDIS) and a world authority on marine science affairs and scientific data and information management. To those who love and study the sea, he was much more. Glenn Flittner, Chief of the National Weather Service's Ocean Services Division, summed up this side of Tommy Austin's career in a personal letter in which he wrote:

"Your retirement signals the end of the oceanographers' pioneering era—it was the likes of you, Elton Sette, Townsend Cromwell, Bell Shimada, and others who unlocked many of the sea's great mysteries. Your findings contributed to global expansion of the commercial fisheries of Japan, the USSR, and to a lesser extent, the North Europeans and the U.S. And your work gave impetus to the U.S.' greatest peacetime era of ocean exploration in the 1950's and early 1960's—an era unlikely to be witnessed again by my generation."

Thomas S. Austin was born in Olean, N.Y. He attended Grove City College in Pennsylvania, as well as the University of Buffalo and Yale University, majoring in biology, zoology, and limnology.

In 1942, he left Yale for the Woods Hole Oceanographic Institution and a winter cruise on the Grand Banks and Georges Bank. This experience was a major milestone in his life. He later said that this first encounter with the awesome power and majesty of the ocean ignited his lifelong love of the sea.

As a wartime Woods Hole oceanographer, Tommy Austin studied the physics of sound in sea water. He spent long hours in submarines and in destroyers—working in submarines to avoid detection by surface vessels by taking advantage of ocean conditions, then working on destroyers to find submarines, despite adverse sea conditions.

His Federal career as an oceanographer for the U.S. Navy Hydrographic (now Oceanographic) Office begun in 1946. In 1946–47, he participated in the Bikini and Eniwetok atomic bomb tests. Later, he spent time at sea, riding out North Atlantic gales and hurricanes on the San Pablo and Rehobeth, narrow, 311-ft. converted Coast Guard seaplane tenders used as oceanographic survey vessels.

In 1951, Austin made a cruise to the Arctic on the Icebreaker Edisto. He was sure it was a career turning point. The grandeur of the ever-changing sea ice and of icebergs moving majestically out from Greenland so impressed him that he then and there decided that the Arctic was to be his life.

On a trip to Europe a short time later, he contracted polio. He was told that he would

never again be able to move anything but his eyebrows.

He did not accept the verdict. After a year of recuperation and tortuous therapy, and now in a wheelchair, he accepted a job with the Bureau of Commercial Fisheries (now NOAA's National Marine Fisheries Service) at its Biological Laboratory in Honolulu. Soon he was working to relate the life history, feeding habits, migration, distribution, and abundance of Pacific tuna to ocean conditions.

Looking back on those days, the late Donald McKernan, one of the Nation's leading marine scientists, wrote:

"Your contributions to those exciting times were of a major nature and . . . you accomplished far more during that period than most scientists accomplish in a lifetime. Later we worked together during my period as Director of the Bureau of Commercial Fisheries and still your enthusiasm and output constantly amazed me and all of the colleagues associated with you."

Thanks to his energy and accomplishments, Austin advanced to Assistant Director of the Laboratory during his last three years in Honolulu. In 1962, he left to become Assistant Director of BCF's Biological Laboratory in Washington, D.C., where he worked to develop a tropical Atlantic tuna study similar to the one in the Pacific. When the Laboratory was moved to Miami, Fla., in 1965, he went with it as Director.

In Miami, Austin spent long hours prior to and after the move working with the architect to assure the best possible facilities for the new Tropical Atlantic Biological Laboratory (TABL) building to be erected on Virginia Key. The completed complex is still a source of great pride for him.

The three-story, air-conditioned structure contains 46,300 square feet of covered work space. Within its two wings are offices, research laboratories, a library, two room-sized refrigerators, a 100-seat seminar room with motion picture facilities, X-ray and darkrooms, a fireproof records vault, a data-processing center, two controlled environment rooms, and an aquarium. Staff and visiting scientists generally work in separate two-room suites containing an office and a laboratory.

Young Navy oceanographer Thomas Austin and Lt. Frank Slattery compare beards aboard Navy minesweeper during Bikini A-Bomb tests in 1946.

Tommy Austin and ham radio station W8HUJ, circa 1932. Dr. Austin is currently licensed to go on the air with the ham radio set presented to him upon his retirement.

The laboratories have outlets for compressed air, gas, and hot and cold running fresh water and sea water. A 2,500-square-foot building adjoining the laboratories contains a large collection of preserved subtropical and tropical fishes, and offices and work space for visiting ichthyologists.

Once the staff moved in—according to those who were there—Austin was everywhere, whizzing up and down halls, visiting offices and laboratories, conferring with staff scientists and visitors. He also attended meetings all over the country, and traveled overseas to numerous conferences. This is classic Tommy Austin behavior, familiar to anyone who ever has worked with him.

BCF's mandate to TABL was broad: an assessment of the biology and ecology of the pelagic marine food resources of the tropical Atlantic, particularly the tunas; the design of programs that would increase the total yield of seafood products, at the lowest possible cost to U.S. commercial fisheries; the extension of assistance, through cooperative efforts, to developing nations bordering the tropical Atlantic, and the acquisition of the knowledge needed for the development and application of sound conservation policies for international as well as domestic control of marine resources.

One of Austin's major accomplishments while working for BCF was his contribution to the planning and coordination of the International Cooperative Investigation of the Tropical Atlantic. ICITA was the first international survey in fishing research and physical oceanography sponsored by UNESCO's Intergovernmental Oceanographic Commission (IOC). He had been a member of the planning group since 1961, and in 1963 took over the job of International Coordinator of ICITA.

ICITA was the most ambitious attempt yet made to study the biology and characteristics of the tropical Atlantic. Seven countries committed 14 research vessels to the investigation, which was carried out in 1963 and 1964. ICITA provided seasonal profiles of the horizontal and vertical distribution of the physical, chemical, and biological properties of the tropical Atlantic from the Tropic of Cancer to the Tropic of Capricorn. Successful completion of this large, complex, and diplomatically difficult undertaking demonstrated dramatically that large ocean areas could be successfully studied through international cooperation.

In 1967, Tommy Austin left TABL to become Director of the National Oceangraphic Data Center, the Nation's repository for unclassified oceanographic data. Through his efforts to improve operations and cut costs, NODC soon acquired its first inhouse computer, as well as equipment to convert analog records to digital form. He also guided development of the National Marine Data Inventory, a system which, for the first time, provided information to the scientific community on the collection and availability of U.S. marine environmental data in advance of their actual submission to NODC or to other repositories. He subsequently sponsored a similar system for international use, which was adopted by IOC member nations.

Internationally, by establishing a recognized world standard for data quality, by implementing procedures which substantially reduced errors, and by judicious use of severely limited resources, Austin developed NODC into a model for the establishment and structure of other national oceanographic data centers throughout the world and a training school

Photo: U.S. Department of Interior

Director of the Tropical Atlantic Biological Laboratory, Dr. Austin welcomed Vice President Hubert Humphrey to the facility in 1966 (top). Four years later he chaired the fifth session of the International Oceanographic Commission's Working Group on International Data Exchange in Geneva.

for their directors, supervisors, and professional staffs.

In 1970, Austin was appointed Director of the then Environmental Data Service. EDS was a pioneering agency that had been created to consolidate data archival and dissemination centers and activities scattered throughout several agencies into a single organization dedicated solely to the management and dissemination of environmental data.

NODC accompanied Austin into EDS and NOAA. Subsequently, EDS also was given responsibility for NOAA's scientific and technical information, publications, and library services; as well as for NOAA's experiment design and data analysis activities for large-scale environmental field experiments. In addition, in October 1974, EDS was given national responsibility for dissemination of retrospective oceanic and atmospheric satellite data.

As he had at NODC, he made extensive organizational and program changes to improve the quality of user services and products, increased automation to reduce costs and provide faster service, strengthened EDS' capability to provide multidisciplinary data and information products, and broadened its participation in international data exchange activities. In addition, he developed a prototpye national referral system for environmental data, information, and literature.

In the spring of 1971, thanks largely to Austin's reputation and accomplishments, the National Science Foundation gave EDS responsibility for data management and information services for U.S. programs in the International Decade of Ocean Exploration (1970–1980). The data collected during the IDOE are being used to anticipate future changes in the quality of the marine environment, forecast ocean and climate fluctuations, locate sea-floor minerals, and improve the use of the ocean's living resources.

EDS also provided experiment design, data management, and analysis support to large-scale, field research programs such as the International Field Year for the Great Lakes and the Atlantic Tropical Experiment of the Global Atmospheric Research Program. More recently, EDIS began operation of the U.S. Global Weather Experiment (GWE) archive for national and international data exchange and developed a complementary GWE global ocean data inventory.

Over the past year or two, Austin has been a prime mover in the establishment of a joint OCZM/Sea Grant/EDIS Regional Coastal Information Center (RCIC) program to provide more efficient information and data access to local constituencies and marine resource managers in coastal states. To date, three RCIC's have been established. Six more have been proposed to cover all U.S. coastal regions, including those of Alaska and Hawaii.

Impressive as these accomplishments are, perhaps Tommy Austin's greatest achievement as Director of EDIS was the development of its capabilities to apply its data, information, and expertise to critical national and global environment-related problems such as the energy crisis, potential global food shortages, envirnmental pollution, and the wise development of the coastal zone.

In support of early national efforts to increase energy resources, for example, EDIS developed tailored data and information products needed to plan, design, build, operate, and monitor the environmental impacts of supertanker ports, floating nuclear powerplants, and the Alaska pipeline. EDIS scientists also played a significant role in the Department of the Interior's national heating oil allocation program during the 1973/74 winter.

Later, with Austin's enthusiastic encouragement, EDIS scientists worked with Dr. Richard Lehman of NOAA's Office of Plans and Programs to develop models to predict

natural gas and electricity demand for the Department of Energy; implemented an operational data base for the DOE's Ocean Thermal Energy Conversion program; developed global crop-yield models and evaluations now used by the Department of Agriculture in its crop-yield assessments and by the Department of State in awarding disaster relief to Caribbean and Sahelian countries; provided climatic guidance needed by architects an builders to design energy-conserving homes; and, in cooperation with DOE and USGS, developed the first detailed maps of geothermal energy sources for the western United States, Alaska and Hawaii, and the Gulf Coast.

In the National Strategic Petroleum Reserve Program, EDIS studies of the potential ecological effects of the disposal of huge volumes of saturated brine into the Gulf of Mexico play a part in decisions as to the location of brine discharge sites and the design of the disposal systems.

The capability of EDIS to undertake these and many other programs and services in direct response to national needs, while improving traditional data and information products and services to a user community that has increased dramatically while he was director of EDIS, is one of Austin's more impressive achievements. But there are still others.

Tommy Austin long has played an important role in shaping national and international policies in marine science and environmental data management. He has been advisor to, member, and chairman of scores of national, intergovernmental, and international conferences, committees, working groups, panels of experts, and symposia. He was Chairman of the IOC's Working Committee on International Oceangraphic Data Exchange from 1968 to 1975 and Chairman of the Panel on International Programs and International Cooperative Organizations of the U.S. Department of State in 1975 and 1976. The latter group determines the U.S. position on international scientific meetings.

Austin was one of the early leaders in formulating policies and programs of the United Nation's emerging International Oceanographic Commission. When he was appointed Chairman of the IOC's Working Committee on International Oceanographic Data Exchange, he forged this large, international body into a cohesive team that was able to recommend and implement a number of major advances in the international exchange of marine data. As a result of these efforts, the amount of data, the quality of data, and the variety of data being exchanged internationally increased rapidly.

He introduced and implemented international inventory systems, the concept of international exchange formats, the concept of Responsible Oceanographic Data Centers to assist the World Data Center system, and many other programs and projects that gained recognition and acceptance by all nations with ocean interests.

When Austin relinquished his chairmanship of the WC/IDOE in Rome in 1975, he was presented with an autographed keg of Frascatti wine signed by all his colleagues. The sight of Tommy Austin casually wheeling through U.S. customs with a large keg of wine on his lap and a saintly smile on his face is one that will never be forgotten by those who witnessed it.

Letters from colleagues all over the world came flooding in when he announced his retirement. A number cited his accomplishments, such as ICITA and the IOC/IODE program. By far the majority, however, were personal expressions of esteem and affection. For Tommy Austin's working relationships have always been person-to-person.

So strong is this bond of affection, that Desmond Scott, Secretary of the IOC wrote to all members, organizing an international collection of personal greetings that were presented to Austin at his retirement.

A message from India perhaps best summed up the international role he has played through the years. It read:
"Your devotion to work and dedicated service to science have greatly enriched the scentific community of the world. We shall greatly miss you at the International meetings."

Closer to home, Secretary Kreps expressed the Department's and NOAA's loss, writing:
"We shall miss your cheerful presence, your boundless energy and wise counsel. . . ."

No one who knows Austin believes for a moment that he is really retiring. Indeed, a recurring theme in the correspondence received from friends and colleagues the world over is the expectation of continued contact, contributions, and friendship.

In the meantime, as President-Elect of the Foundation for Science and the Handicapped, Tommy Austin is deeply immersed in programs and projects to encourage handicapped youths to enter the field of science. On past performance, his efforts will not go unnoticed. □

Photo: Graphic Division Environment Canada

NOAA Administrator Richard A. Frank scores a point at the Tommy Austin retirement "roast".

Dr. Thomas Austin and his wife Jane (left) at an IOC Executive Board meeting in Ottawa, 1974.

The invisible blankets: where do they go?

By LOUISE PURRETT-CARROLL

The Shape Of Pollution

From the exhaust of a single automobile to the emissions of nuclear tests, pollutants are entering the atmosphere on a global scale.

Where all this will lead is anybody's guess—but nobody can make even a good guess until science learns what happens to the pollutants once they are released.

Where do they go?

Prediction of the effects of global pollutants depends on knowing how they travel through the atmosphere. To find out, scientists at NOAA's Geophysical Fluid Dynamics Laboratory in Princeton inject different "pollutants" into computer models of the global atmosphere, and see what happens to them over periods of months and years.

Researchers at the laboratory have been developing and refining computer models of the global circulation of the atmosphere. The most complex and realistic model takes into account seasonal changes in sea surface temperatures and radiation from the sun, the shape of the landscape, clouds, moisture, the influence of elements such as carbon dioxide and ozone. Dr. Jerry D. Mahlman and others have been using such models to predict the large-scale dispersion of pollutants.

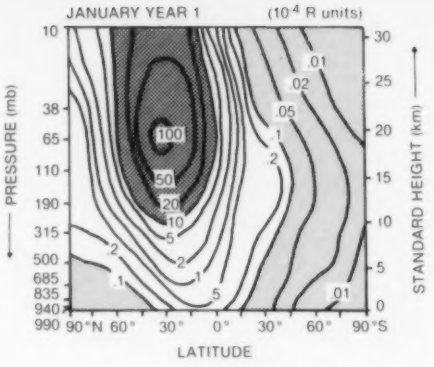
One experiment simulated the spread of "debris" from a mock nuclear explosion in the stratosphere. In the real world, radioactive particles and gases from high-altitude tests of thermonuclear warheads are carried thousands of miles through the atmosphere. NOAA's Air Resources Laboratories track the passage of the radioactive clouds as they sail high over the United States.

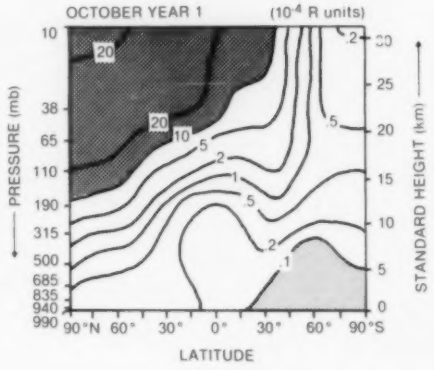
For this experiment, Mahlman and a colleague, Walter J. Moxim, used a complex, three-dimensional model that simulates atmospheric circulation at 11 heights up to an altitude of 18.6 miles (31 kilometers). The horizontal resolution of the model—the smallest distance over which it defines movements—is about 159 miles (265 kilometers). Mahlman and Moxim used this model's simulations of upper atmosphere winds in another model that predicts the progress of a neutral "tracer," a "pollutant" that will not react with the atmosphere, but will be carried passively by the wind.

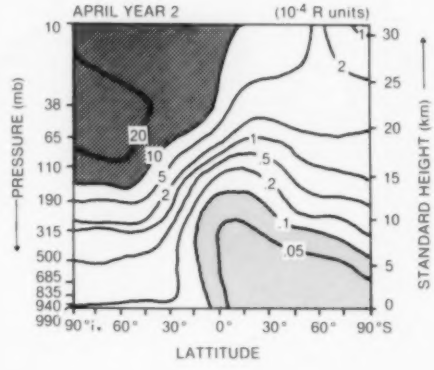
Measurements in the wake of actual mid-latitude nuclear tests indicate that what happens to the debris over the long term—periods of six months or more—has little to do with the time of year or the weather that prevailed when the device was detonated.

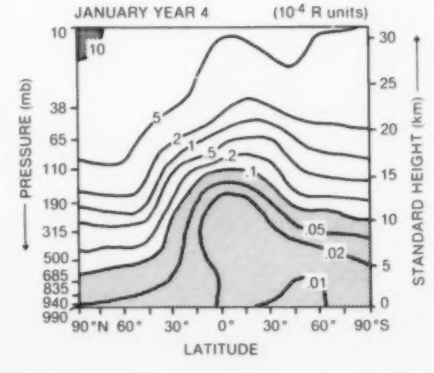
In the tracer model, Mahlman and Moxim released a megaton "bomb" on January 1, in the stratosphere over the North Pacific. They then followed the dispersion of the "radioactive debris" through several model years. The debris dispersed rapidly at first. By April in the first year large quantities of it had descended into the troposphere (the lowest layer of the atmosphere) at about 30 degrees north latitude, and into the stratosphere of the southern hemisphere.

By July, it was moving rapidly downward and toward the poles. During the following summer months, it began to descend into the lower levels of the southern hemisphere. The spread of the debris slowed during the second year, and by the third year the global dispersion of the tracer was evolving so slowly that seasonal changes in the winds began to dominate.









Another way of looking at a stratospheric pollutant, continue the researchers, is to see how long it stays in the stratosphere—its "residence time." The stratospheric residence time of the tracer in the simulation, they found, doubled over the span of the experiment. In the northern hemisphere, the residence time varied with the seasons; it was longest from November to January, shortest from April to July, when it made an exodus from the northern to the southern stratosphere.

All this suggests, say the researchers, that the present system of using observations made only in the northern hemisphere to infer residence times for radioactive debris may be misleading. The situation can be very different in the southern hemisphere.

As time passed, the simulated debris not only spread out, it rose. This ascent of the average center of mass of the tracer was correlated with the increased residence time—the higher the tracer went, the longer it stayed where it was. Mean residence time increased by about four months for each kilometer rise in the center of mass of the tracer.

This explains the puzzling observation that after actual detonations in the atmosphere, radioactive carbon dioxide in the debris cloud seems to have a longer residence time than particulate matter, even after the particles' tendency to fall is taken into account. The larger bombs, which produce carbon dioxide, have a hotter fireball, and rise higher in the atmosphere, than smaller bombs, which produce particulate debris. So the carbon dioxide has a longer residence time because it started out at a higher altitude. This, and the fact that the residence times in the simulation fall between those observed for different components of debris from actual explosions, lead Mahlman and Moxim to warn against using the behavior of any one substance to construct simple models describing the transport of debris from such an explosion.

The north-south movement of the mock debris seemed to result from complex interactions between horizontal and vertical air movements in both the average, prevailing circulation and in eddies in the atmosphere. The eddies did most of the dispersion at first, but later their effects were cancelled by the average circulations, except when changing seasons brought transitions in circulation patterns.

During the winter, the air currents caused a buildup of the tracer in the lower stratosphere, placing it on a lower stratospheric loading dock for quick transport into the troposphere. In the spring, sinking air feeding into developing cyclones—large-scale rotating air masses associated with low pressure—conveyed the debris into the troposphere at latitudes 50 to 60 degrees north.

The researchers then turned to the question of what happens to the tracer once it arrives in the troposphere. If it is to be removed from the atmosphere, this will be the point of departure. In January of the third year, most of the tracer coming down in mid latitudes from the lower stratosphere was washed out of the atmosphere by rainfall. The rest was blown to the tropics

to be washed out by the heavy rainfall there. By July, the cyclonic activity, and the main descent of tracer, had moved to higher latitudes. In the subtropics, horizontal eddies carried the substance southward, causing a build-up near the equator.

To see how realistic this simulation was, the researchers compared the July distribution of tracer in the model to the July distribution of radioactive zirconium from an actual test in late December of 1968. The two patterns were similar. The zirconium showed the same poleward-downward movement as in the simulation, and the protrusion of tracer into the lower stratosphere of the southern hemisphere. They differed mainly in the extent of some of these patterns.

Other experiments at the Princeton lab deal with the worrisome exhaust from supersonic aircraft traversing the stratosphere. It is feared that water vapor, nitrogen oxides, and particles in the exhaust could have noticeable effects on the composition of the stratosphere, and "all three of these effluents," says Mahlman, "pose a rather subtle problem in that they may produce long-term changes in the atmospheric circulation." Such a change could in turn affect earthly climate patterns. The nitrogen oxides are a vital link in the chain leading to destruction of ozone in the stratosphere.

To assess the potential effects on ozone or climate, says Mahlman, scientists need to know how the present circulation patterns could disperse the effluent away from the busiest flight corridors.

Most projections of travel routes and numbers of flights, says Mahlman, place the great majority in the lower stratosphere of the middle northern latitudes. This region of the stratosphere has strong east-west wings; the impact of effluent on the climate of the atmosphere as a whole will depend on how fast the material is blown to other latitudes and altitudes.

In a preliminary experiment several years ago, Mahlman visualized the streak of effluent that would be left by real planes as a series of individual releases, six hours apart, at one spot. He than let the model run for 11 "months" and estimated the effects of such long-term injections by using the results from a single injection of the same tracer.

After 11 months, the stratosphere of the model showed, on the average, a thousand-fold increase in concentrations of the tracer over the global average amount produced by one six-hour injection. Near the orignial source of the tracer injection, it multiplied concentrations by 3,800.

In mid-latitudes, the tracer had descended into the lower atmosphere. But even after 11 months, very little had seeped into the southern hemisphere—there was still about 7.5 times as much of it in the northern hemisphere. About 36 percent of the total amount of tracer had been removed from the atmosphere by precipitation or by sifting down to the ground.

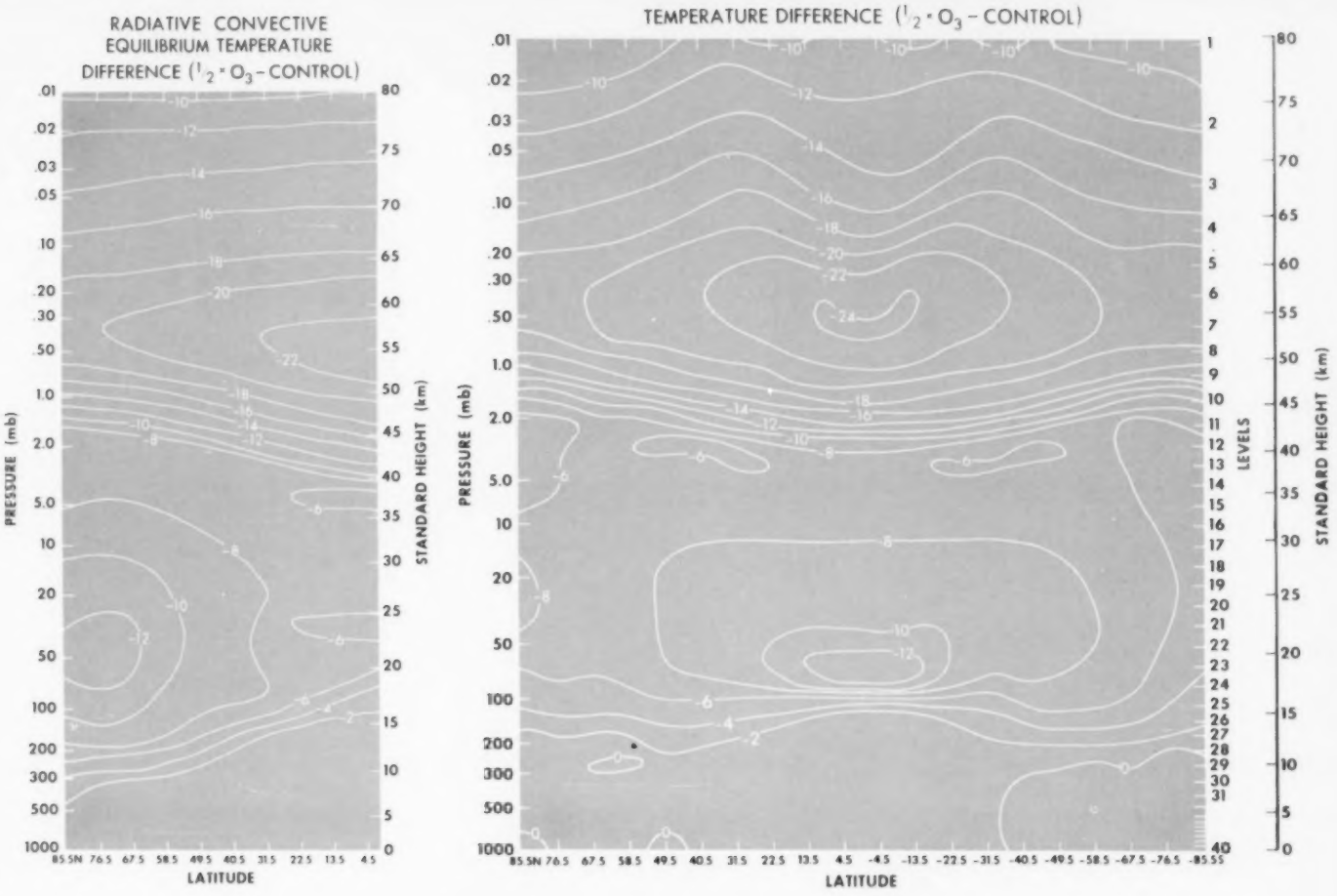
Mahlman is now working on a much more comprehensive and, he believes, realistic simulation of the dispersion of SST emissions. Much more is known now about how many of what kinds of planes will be flying, he explains. The new experiment is based on assumed flight paths of British and French Concordes.

Photo: EPA Documerica

Automobiles and trucks are the single largest source of pollutants entering the atmosphere.

Another important ozone-destroyer is formed when nitrous oxide is destroyed in the upper stratosphere. The widespread use of fertilizers may indirectly add tons of this substance to the atmosphere each year. But very little is known about how much it varies geographically, and where it all comes from.

"In the old school of thought," says Mahlman, "there are large natural sources and sinks (destruction or removal mechanisms) for nitrous oxide in the lower atmosphere, and its concentration varies a lot from place to place." But, as methods of detecting and measuring nitrous oxide in the atmosphere have improved, he continues, they have shown less and less variability in the amounts of the gas. Nor can anyone come up with a reasonable mechanism by which significant amounts of nitrous oxide might be destroyed in the troposphere. The main requirement, he says,


RADIATIVE CONVECTIVE EQUILIBRIUM TEMPERATURE DIFFERENCE (½ × O3 – CONTROL)
TEMPERATURE DIFFERENCE (½ × O3 – CONTROL)
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85 SN 76.5 67.5 58.5 49.5 40.5 31.5 22.5 13.5 4.5 -4.5 -13.5 -22.5 -31.5 -40.5 -49.5 -58.5 -67.5 -76.5 -85.5 S

A computer simulated structure of atmospheric temperatures at different altitudes and latitudes under present conditions, left, and with half the present amount of ozone, right.

is that the amount destroyed in the stratosphere must somehow be replenished by net production of an equal amount in the troposphere.

"We challenged the old view by asking a simple question: suppose we set up conditions leading to minimum variability—a small constant source of nitrous oxide with its only destruction in the stratosphere and with a global chemical lifetime of 150 years. How will the present-day circulation of the atmosphere distribute this substance?"

In one experiment, Mahlman, Moxim, and Hiram Levy II assumed that nitrous oxide is emitted uniformly and constantly from the surface of the earth, at a rate equivalent to the amount estimated to be destroyed in the stratosphere. The researchers set "time" in motion and the model atmosphere evolved until the nitrous oxide reached equilibrium, with the amount entering the atmosphere balanced almost exactly by the amount destroyed. The nitrous oxide had distributed itself nearly uniformly throughout the troposphere.

In the stratosphere, the nitrous oxide thinned drastically toward the poles, and more of it reached higher in the tropics than elsewhere. Scientists in NOAA's Aeronomy Laboratory, who send instrument-laden ballons aloft to measure various substances in the upper atomsphere, have observed all these features.

In another experiment starting with the nitrous oxide distribution produced by the first simulation and assuming that nitrous oxide comes only from rainy areas of earth, there was slightly more variability in the final concentrations of the gas in the troposphere.

The important point, says Mahlman, is that the variability in all these experiments is in the range of the latest measurements. They show that a much smaller input than had been suspected can account for observed variability of nitrous oxide. This means, he continues, that it might be easier for man to change the amount of nitrous oxide—and, therefore, of ozone—in the atmosphere.

All these experiments dealt with a passive tracer. They assume that the interaction between atmosphere and tracer is one-way—that the tracer does not affect the winds that carry it. The researchers also conduct active experiments to determine what effects altered pollutant concentrations might have on the atmosphere.

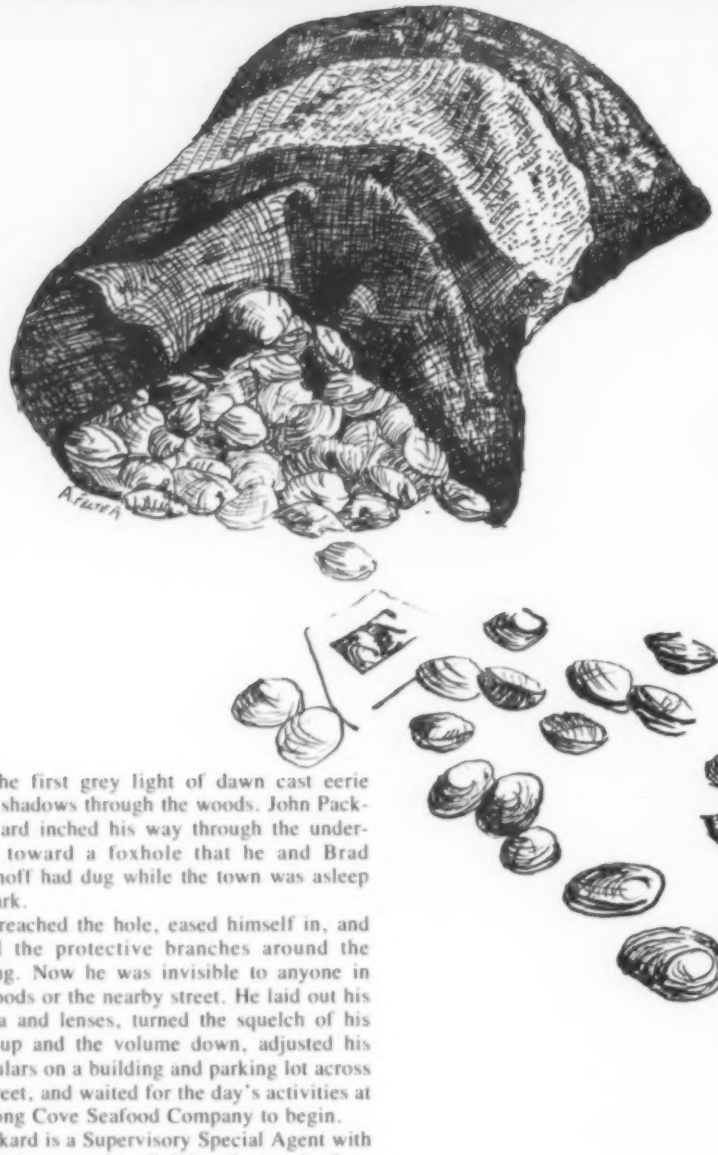
If SST's and fertilizer can cause ozone destruction, what would be the climatic effect of this destruction? Where in the stratosphere will it be greatest, where least? Mahlman and his colleagues Russell W. Sinclair, Stephen D. Sels, and M. Daniel Schwarzkopf used the latest version of the general circulation model to find out.

The model they used has 40 vertical levels, the highest at 48 miles (80 kilometers). With all other conditions the same, the researchers ran two simulations. In one, the earth's ozone was set at present-day levels. In the other, it was cut in half. They ran both model earths for 160 days, and looked at conditions during the last two months of that period.

In the half-ozoned earth, there was "substantial" cooling in the upper reaches of the atmosphere—as much as 41 degrees F. (23 degrees C). Smaller changes occurred lower in the atmosphere. The stratopause, the upper boundary of the stratosphere, dropped by about 3½ miles (6 kilometers), while the tropopause, the lower boundary, rose by about half a mile over the tropics. The temperature difference between the tropics and the poles shrank by several degrees, and westerly winds in the stratosphere and above slowed by as much as 34 miles (54 kilometers) per hour.

Such experiments, Mahlman cautions, are not perfect predictors of pollution dispersion. Nor are even the most advanced computer models perfect imitators of atmospheric circulation, though they are now very realistic.

But the experiments do provide insights that the most extensive measurements could not, and can simulate in a few months events decades in the future, while there is still time to do something about them. □



How Lenny the Hatter helped NMFS agents nab Big John

The Great Clam Caper

By GERALD D. HILL, JR.

The first grey light of dawn cast eerie shadows through the woods. John Packard inched his way through the underbrush toward a foxhole that he and Brad Romanoff had dug while the town was asleep and dark.

He reached the hole, eased himself in, and pulled the protective branches around the opening. Now he was invisible to anyone in the woods or the nearby street. He laid out his camera and lenses, turned the squelch of his radio up and the volume down, adjusted his binoculars on a building and parking lot across the street, and waited for the day's activities at the Long Cove Seafood Company to begin.

Packard is a Supervisory Special Agent with a little-known crime-fighting force, the Law Enforcement Division of the National Marine Fisheries Service. On that morning in 1976, he and Special Agent Romanoff were building a case against a gang of Long Island, N.Y., poachers who were doing a multimillion dollar business in the sale and transportation of illegal, undersized clams.

Packard explains that he first learned of this operation in June 1974, from an article in a special edition of *Newsday* on The Great South Bay. "From that day on, for almost four years, I worked with members of Suffolk County Marine Police and the New York Department of Environmental Conservation to track down the poachers."

During the course of the investigation the NOAA agents and other law enforcement officers spent countless hours following trucks which were carrying the illegal clams into New Jersey, Pennsylvania, and New York. Romanoff passed himself off as "one of the boys" of organized crime, from the streets of New York City, in order to learn more about the operation. Packard managed to infiltrate the poachers' organization with another undercover agent who taped telephone conversations with them, sold them illegal clams furnished by Packard, and gradually exposed their method of operation.

In New York State it is illegal to harvest, buy, or sell clams less than one inch in width, or to take any from uncertified areas. There is, however, a great demand for these small clams, considered a specialty in numerous bars and restaurants in the Northeast.

In addition to violating State law, poachers are also violating Federal Law—the Lacy Act—which makes it a Federal offense to cross State lines with wildlife taken in violation of a State law. That's what brought the fisheries agents into action.

Normal size clams are sold in 65-70 pound bags containing 500-550 clams. Illegal or seed clams are sold in 70-pound bags of 1200-1500 clams. The seed clam diggers get about $45 each for the 70-pound bags which eventually are sold at retail for about $100 with most of the profit going to the middleman.

"We kept a very low profile during the investigation that followed our initial contact with Sgt. Don Hoffman of the Suffolk County Marine Police and Lt. Bill Ward of the Department of Environmental Conservation," said Packard. "We figured if word got out that the Feds were on the case, the poachers would reduce or stop their operations. Also, we really didn't know who we could trust, so we kept our contacts with the other law enforcement agencies to the barest minimum

"The poachers were extremely smart, even ingenious, in some ways. But in other ways they were just plain dumb," he said. "On the one hand, they used pleasure boats which had the insides removed and replaced with clam dredges. They could dip and bag hundreds of pounds of illegal clams while just appearing to be in a pleasure cruiser out for a day's fishing. On the other hand, we found the same people keeping written records of the numbers of bags of illegal clams that were being bought and sold."

Because of the large numbers of clams that were being sold illegally, the agents assumed the poachers must be using dredges. Early in the investigation Packard obtained the use of a Suffolk County Marine Police helicopter and began flying over the Great South Bay, searching for the illegal dredges.

"As we flew over the area we spotted two types of tracks on the bottom, said Packard. "One set of dredge tracks would go in circles and the other in a straight line. It became obvious to us that the legal dredgers were working in a circle, while the poachers worked in a straight line so as not to arouse suspicion."

Although aware that the legal clammers had a good idea who the poachers were, the police found it difficult to get the local people to divulge anything. The clammers were afraid of reprisals to their own boats.

"We finally persuaded one person to talk about the illegal dredges," said Agent Packard. "He told us that one of them was docked in a grey boathouse with white trim, the fourth house on a bulkheaded canal between Brightwater and the Nassau County line."

Top, one of the major outlets in Pennsylvania for clams taken illegally in Long Island waters. Left, an illegal clam dredge appearing to be a pleasure craft. Right, a cleverly hidden illegal clam dredger.

Packard spent many hours searching canals before finally locating the boathouse. "As we flew over it we spotted a van parked nearby, and by tracing the license plates we found that it belonged to a known clam poacher," he said. "We got a boat and cruised very slowly up the canal and were lucky enough to pass by when they had the door to the boathouse open. So we were able to take pictures of the boat."

Believing they had probably found the location of the illegal dredge, Packard and his agents began asking questions of residents. They were fortunate to find a retired New York City Police Detective who lived across the canal.

"He told us that strange things had been going on in the boathouse," Packard said. "He said that when he first moved into his house, the door on the boathouse had made a lot of noise when it opened. Now it was greased and, for some strange reason, the inside of the boathouse had been covered with aluminum siding.

"He also told us that the boat only went out in the wee hours of the morning without lights and always returned before dawn. The detective was awakened when they returned by the noise of what sounded like people loading and unloading bags of clams."

Packard believed he had a good fix on the illegal dredge so he kept the boathouse under surveillance, and soon found his informant's suspicions correct.

The major target of the investigation was a dealer known as Big John who owned the Long Cove Seafood Company. He had begun as a parttime buyer and digger in the early 1970's, but overnight he developed a large operation with many trucks and other vehicles. The agents believe he was financed by another organization, but the connection was never proven.

With a market for all the small clams he could furnish Big John bought seed clams from many sources, primarily small diggers. The agents discovered that their suspect had established many pickup points, where his contacts dropped off their clam catch, in abandoned bakeries, vacant houses, garages and barns. People who worked for him collected the clams and took them to the seafood company where Big John used a system of numbers to keep his various suppliers and buyers straight. Each seed clam supplier was given a number. Whenever the supplier dropped off clams, he placed a tag on the bag and Big John knew how to make payment when suppliers came to him later.

"We knew that Big John was bringing the illegal clams into his place of business," Packard reflected, "but we didn't think he was keeping them there for any length of time.

"It became obvious that it was time to get somebody inside the operation. We learned of a man in town—'Lenny the Hatter'—who had been in the seafood business but had lost his business and his home after being taken in by a number of sharp dealers. We approached him on the theory that he'd agree to work with us in getting evidence."

Their judgment was accurate. Lenny worked undercover for the law enforcement agencies for the next four years. Armed with a tape recorder, he began his contacts with Big John. (Under Federal law conversations can be tape recorded and used as evidence in court if one of the persons in the conversation knows that it is being taped.)

"At first Big John was reluctant to discuss the sale of illegal clams," Packard recalled, but Lenny finally won his confidence, and Big John bought some of his clams.

"We went to the legal clam dealers in the area and explained the investigation that we were conducting, and asked them to furnish us with undersized clams that they caught during their operations. Normally they would have

Left, one of many collection points for illegally taken clams. Below in a photograph taken from the foxhole an ice cream truck delivers illegally caught clams to the dealer. Below left, illegally taken clams are confiscated. Below center, one of the large trucks used to transport illegal clams to Pennsylvania retailers. Below right, a night-sighting equipped camera documents an illegal transaction.

been tossed back in the Bay after they were caught, but to keep us supplied the clammers brought them in and we counted, weighed, and bagged them for Lenny to sell to Big John," said Packard. "Whenever a sale was made to the poachers, the bags were kept in sight from the time they were prepared until they were delivered to the poacher." The agents gathered their evidence painstakingly. When Lenny was due to deliver the clams to one of Big John's men, Packard cautioned him to call and complain to Big John if the man was more than 15 minutes late. Lenny's contact never arrived, so Lenny brazenly called Big John who promptly appeared at the scene.

"That was a real break for us," gloated Packard. "As we sat close by snapping our cameras, Big John took the illegal clams from Lenny's car and loaded them into his own vehicle." Another piece of evidence had been obtained.

"About the second time Lenny sold clams to Big John we cut the weight on the bags so that they would be short." said Packard. "We wanted to be sure that we had a good case and could definitely prove that the illegal clams sold by Lenny were being bought by Big John. Big John called Lenny and complained about the weights, giving the weight of each bag. The weights were identical to those of the bags that Lenny had furnished."

Unfortunately, Big John caught Lenny away from home, so Lenny wasn't able to record the conversation. "I told Lenny to call back and tell Big John that he had lost the paper with the bag weights on it," Packard said. "As Big John repeated the short weights, Lenny wrote them down—and then told Big John that he would give him another bag to make up the shortage. Nothing more was said about the short weights."

About then police learned that the people whose dredge was in the boathouse were beginning to feel uneasy and were planning on moving it to another location. Because the poachers trusted Lenny, Packard proposed that he tell the dredgers of a New York friend who was interested in getting into the business and wanted to come out and look at the boat.

That's how the second undercover agent was introduced into the operation. Romanoff had grown up in New York City and was skilled in street ways and talk. He was introduced as Billy Romano, a legman for organized crime.

"We were fortunate that Brad was able to pull it off so well," said Packard. He met with the dredgers twice and learned how the dredge was constructed, how much it cost and how it operated—and he also learned the names of the illegal clam dealers."

The dredges were ingeniously modified. They appeared to be normal pleasure craft, like thousands found on Long Island Sound. Operated by two or three people, they sometimes carried others on the deck who appeared to be fishing. But below the insides of the cruisers had been gutted and replaced with dredging machinery. Clams would come up with the dredge, pass along a series of chutes where they were culled and washed, and then fed to the end of the line where they were dropped into the bags, weighed and tied for delivery. One such boat could dredge several hundred pounds an hour.

"As the investigation continued it became obvious that we needed to watch Big John's place of business," said Packard. "That's when we hit on the foxhole idea. We dug it across the street, so we could keep an eye on his work place as well as the large vacant lot next to his clam house."

They watched for a few days, and noted large trucks moving continually from the shop to the vacant lot. It was apparent that the seed clams were moved from the shop and loaded directly onto the trucks in the lot.

"A funny thing happened while I was in the foxhole one day," Packard related. "I was watching the shop when I heard someone calling his cat. Well, the cat came right to where I was, and his master followed. The man stood right next to my arm for several minutes, calling for his cat, without even seeing me. Finally he looked down and jumped with surprise I motioned for him to be quiet and to move away. He recovered his composure and left without saying anything. Later I went to his house to explain what we were doing, and he offered the use of his porch as a place to watch Big John's business. As we spent more and more time on his porch, he began having breakfast for Brad and me when we arrived each morning. Brad even raked his leaves at times so that it appeared that he was a workman, while he watched Big John's operation."

Packard received a report through Sgt. Hoffman of the Marine Police that one of his officers, fishing one night, had noticed a party boat running very slowly close to shore. He also saw several small boats making runs from the party boat to the shore, and unloading bags of clams into vehicles on the shore. Among them was an ice cream truck.

"I didn't think much about it at the time," said Packard, "but, as I was watching the shop from the foxhole one day, what should appear but an ice cream truck. He backed up to the door of Big John's shop and began unloading bags of clams."

Big John's major customer was Yates Seafood, a small store in Ashley, Pa., that in turn sold the clams to restaurants and bars.

During the course of the investigation Big John changed his operation somewhat by shipping the clams out of New York State in vans and stations wagons. The small vehicles took their clams to the parking lot of a motel in Englewood, N.J., where they met the larger truck that would make the run to Ashley. The large truck would appear with bags of legal clams piled to leave space along the sides of the truck where the illegal clams were stashed and covered with legal clams for the final trip.

By spring of 1977, Packard and the New York officials had the evidence they needed. Using 23 agents teamed with Suffolk County Police Officers, they moved in on the ring and subpoenaed the records of the dealers in Pennsylvania and others involved. In June, a Federal Grand Jury handed down 34 indictments, and 27 NMFS agents, again teamed with Suffolk County Police, arrested the 34 in a predawn raid.

Lengthy pretrial maneuvering followed by the sentencing of some gang members who then turned State's evidence, led 28 of the 34 to plead guilty. Charges against the other six were dropped by the prosecutor's office.

Big John was fined $15,000, given a 3-year suspended sentence with 5 years' supervised probation, and his company was fined $15,000. The others were given lesser sentences—the lowest a $500 fine and 1-year suspended sentence with supervised probation. Two Pennsylvania seafood dealers were fined $3,000 plus 3 years' supervised probation.

Did Packard's great clam caper put an end to illegal seed clam operations? "I guess there must be some of it still going on," said Packard, "but not on as large a scale as before."

As for Lenny, he never had to face the gang he'd worked with so long, because they all pleaded guilty. The poachers learned he was an undercover agent just before the trial, but by then he was hidden away. Unpaid for all his time as an undercover agent, Lenny was given the profits from his clam sales during that period. With seed funds from his seed clams, he now lives, with a new identity, in another part of the country. □

John Packard is a professional law enforcement officer, methodical, patient, and with a long and varied background. He spent more than 10 years in the military services as a criminal investigator and commissioned officer; he was an instructor at the Army's Military Police School in Ft. Gordon, Ga., for over 2 years. He served as Police Chief of Winsted, and then in Old Saybrook, Conn. An investigator for the Navy in Newfoundland, who also served with the U.S. Customs Service on the border of Texas, he came to the National Marine Fisheries Service in April 1974. Packard earned a B.S. from Northeastern University, Mass., and holds a Masters degree in Criminal Justice from American International University, Pasadena, Calif. He is using this case for the dissertation for his Doctorate in Criminal Justice at American International University.

Economy Up, Pollution Down

The Hyde County Story

By VIRGINIA WORTHINGTON*

The consequences of septic system failure.

Two years ago the construction industry in North Carolina's Hyde County faced a dilemma that bordered on disaster. Conventional waste disposal systems had proven unsuitable for most of the soil in that coastal county, and 70 percent of the new construction permit applications—valued in the hundreds of thousands of dollars—were being rejected.

The industry faced similar problems in nearby Craven County.

Additionally, valuable shellfishing waters surrounding those counties had to be closed to watermen, in part at least because of the waste disposal problem.

Today, all but a few permit applications are approved in both counties, and nearly 200,000 acres of shellfishing waters have been reopened.

A key figure in improving the situation was Soils Extension Specialist Bobby Carlile of North Carolina State University, who for the past three years has been supported by NOAA's Sea Grant Program. His work is far from finished, but his efforts to improve onsite waste disposal in the coastal zone have had a major impact in North Carolina and several other coastal States.

Throughout North Carolina the news of Carlile's work is spreading fast. In the last three years more than 100 low pressure distribution and 10 mound systems—systems he has developed—have been put in along the State's coast under his supervision. Dozens more have been installed by contractors and individual homeowners who have found out about the systems at workshops led by Carlile.

In Hyde County local health officials make no bones about the fact that Carlile's work has made the difference in the county's ability to grow. The sparsely populated, agricultural county is bounded to the south and east by one of the State's most important bodies of shellfishing water, Pamlico Sound. Nearly 90 percent of the county is unsuitable for conventional septic systems because of high water tables and poor soils. In the past, closure of much of the shellfishing waters adjacent to the county was thought to be a result of pollution from failing septic tanks. Dawn Cahoon, the

* *Virginia Worthington was until recently a writer-editor with University of North Carolina Sea Grant.*

county's sanitarian, credits Carlile and his low pressure distribution system for much of the improvement.

In nearby Craven County, sanitarian Al Harris has similar comments about the impact of Carlile's work. "We've been able to use so-called marginal lands that otherwise we'd have no choice but to turn down," he said. "The alternative systems allow us to have economic growth, yet we're protecting the environment."

Further inland, Carlile's systems have been adapted for limited use in difficult piedmont clays and on steep mountain slopes.

According to Carlile, the disposal problems of coastal North Carolina typify those facing many other rural coastal States. Though growing, the State's coastal population is still relatively unclustered, and, in many areas, fluctuates seasonally. From an economic standpoint this makes the once popular notion of "sewering the countryside" with centralized collection and treatment plants impractical.

Private septic systems, on the other hand, are often inadquate because of high water tables and poor soils. Carlile estimates that in many areas of coastal North Carolina nearly 90 percent of the soils are unsuitable for conventional septic systems. Nationally, the Environmental Protection Agency estimates that as much as one-half of the soils are unsuitable.

But effective, low-cost alternatives to sewers and septic tanks do exist. Researchers have found that the basic septic system design can be modified and improved so that it will work under a variety of conditions. "If it weren't a good system to begin with," muses Carlile's assistant, Dennis Osborne, "it wouldn't still be around after nearly a hundred years."

Poor soil conditions are not restricted to a single geographic area. But along the coast the problems they cause are compounded by the presence of high water tables. From Carlile's perspective, that's where the real headaches begin.

"When you try to put sewage in ground with a high water table, it's just like trying to put water into a jug that's already full," he explains. "When a soil is saturated and you put more water into it, you don't get the degree of treatment that you have in aerated soils."

Faced with those conditions, property owners in the past have had little choice but to invest in expensive chemical treatment units or holding tanks or simply sell their land. According to Carlile, this isn't always necessary. In many instances the homeowner or developer can install a modified septic system that will work where a conventional one won't, and at only a slightly higher cost. The key, he says, "is to make the system fit the site."

Much of Carlile's work has focused on the modification of two alternative onsite systems suited for coastal environments. The low pressure distribution system utilizes the natural soils at the site. Nearly identical to the conventional septic system, it uses a low pressure pump to distribute the effluent efficiently and uniformly over the entire soil absorption area, via a network of small diameter, perforated PVC (plastic) pipes. Distribution lines do not have to be placed deeply in the ground and the effluent can be pumped upward, away from water tables and into better soils.

A low pressure system installation site at Holiday Island. Note that the only visible signs are the green patches of grass outlining the location of the distribution pipes.

Carlile estimates the cost of the typical low pressure system at about $1500, about 25 percent more than a conventional septic system. The system requires virtually the same amount of land as a conventional septic absorption field.

The mound system is another modified system with which Carlile has worked extensively. But he considers it only as "a last resort" for areas where natural site and soil conditions are so poor "that an essentially artificial system must be hauled in or constructed."

In this system, the absorption field is a layered hill of loamy fill, gravel and sand which effectively treats the wastewater before it reaches the natural soil surface. A low pressure system is placed inside the mound so that the effluent is evenly distributed.

Methods to reduce the total volume of household wastewater also are getting attention in many areas. Through the use of toilet dams and water-saving shower heads, household water consumption levels can be reduced by as much as 30 percent. Bob Rubin, an engineering specialist with the North Carolina Agricultural Extension Service, said that a simple reduction in the waste flow can sometimes make the critical difference in getting a treatment system to work on a problem site. In many locations, Rubin and Carlile have worked together in designing treatment systems which incorporated water conservation practices with alternative disposal methods.

Despite the success of his work in North Carolina, Carlile is the first to emphasize that the systems won't work everywhere.

"Some people get the idea that with alternative systems you can build in the marsh," he said. "The fact is that we're still looking at sites that are unsuitable and can't be developed."

Questions have been raised over the effectiveness of alternative systems in removing potentially harmful bacteria and viruses. Viruses are particularly difficult to filter out because they are so small and can rapidly migrate through pores in the soil.

As part of a Sea Grant study, microbiologist Mark Sobsey of the University of North Caroline at Chapel Hill has been looking at the effectiveness of the low pressure and mound systems in removing bacteria and viruses in wastewater. At Holiday Island, a test site along Albemarle Sound in the northeast section of the State, Sobsey has carefully tested for virus contamination of surface waters in manmade canals. Nearly half of the disposal systems in this second-home development have been modified. So far, his monitoring has failed to turn up any viruses.

Although Sobsey and Carlile agree that further testing will be needed at other sites, both are encouraged by the preliminary results and what they may mean for the future of septic waste disposal in coastal North Carolina and elswhere.

Their optimism is shared by Jim Kreissl with the Municipal Environmental Research Laboratory of EPA's Wastewater Research Division.

"These are extremely powerful tools," he said. "This alternative is really improving the situation of many small communities." □

Summer Job At The White House

By JOHN STRINGER

Photos: Bob Williams

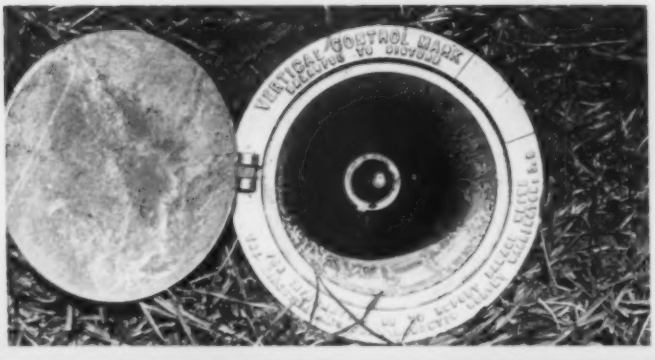
The job was coded YF, and it had been assigned to National Geodetic Survey Mobile Field Party G-37. Routine numbers but the job location was decidedly not routine–it was the White House, where the unit was to detect any movement of the bench marks set in the walls during the reconstruction 27 years ago.

Joseph D. D'Onofrio, Chief of the NGS Field Operations Branch worked with Charles T. Whalen, Chief of the Vertical Network Branch and Emery Balazs, NGS Project Manager, in planning the White House project, which included determining which bench marks were to be surveyed and installing a new bench mark on the grounds of the Executive Mansion.

In June, 1977, a month before starting the releveling survey, NGS Survey Technician Gordon Vaughan and members of the Mobile Drill Rig Unit arrived in Washington, D.C., to install the new vertical control marker on the south lawn of the White House.

While Vaughan adjusts a control lever on the rig, Lt. (j.g.) Ronald Philippsborn readies the drill used to install the mark, which will assist NGS surveyors in determining whether the executive mansion and the surrounding area are settling. Once installed, the bench mark will be surveyed, and its elevation accurately determined. Like hundreds of thousands of other bench marks, it will become part of a network of basic reference points which are used for all manner of surveying, engineering, planning and scientific projects. For example, the bench marks might form the basis for a mapping project, or for the construction of a highway or pipeline.

Philippsborn holds the new marker's access cover. Placed in a protected and inconspicuous location near the White House tennis courts, the new bench is designated "RS" for Rex Scouten, the Chief Usher of the White House, who has requested the NGS to conduct periodic surveys since the reconstructed building was completed in 1952.



The new marker consists of an inner steel rod driven about 40 feet into the ground. Encased in a plastic PVC pipe, the inner rod is protected against corrosion, frost heave, and soil expansion and contraction by a heavy grease pumped into the space between the casing and the rod.

Once tied into the national network of elevations maintained by the NGS across the country, the new marker will be used to determine whether there has been any vertical movement of earth. Other bench marks in the Washington, D.C., area whose precise heights have been determined and published over the years include those of Rock Creek Park, the Capitol, and the Washington Monument.

A month after the installation of the new bench mark, members of the NGS Mobile Field Party G-37—Ronnie Taylor, Field Coordinator Karen Donovan, Recorder, and Anita Whitis, Observer, began the re-leveling project at bench mark "T4-METRO BANK-BB3," located on Connecticut Avenue several blocks northwest of Lafayette Park.

One of the bench marks—a METRO deep rod mark—is under the sidewalk next to the Treasury Building on 15th Street. Rodman Albert H. Herrick and other members of the team use instruments so precise that they can determine earth subsidence to within thousandths of an inch.

Whitis "aims the rod" while Donovan prepares to record the required six observations at each site. Of the 48 bench marks included in the new survey, 40 are located in the White House walls.

Measurements from the METRO deep rod marks in Lafayette Park and next to the Treasury Building, and from a bench mark disc set in the wall in front of the Executive Office Building, are compared with measurements at other key points in the immediate area, all part of the Capital's geodetic survey network.

During the 1948–52 reconstruction of the White House, almost invisible markers were imbedded in the outer walls of the east and west wings and at the base of the pillars in front. At that time, NGS surveyors detected areas where the earth was settling, resulting in some walls cracking. After this was corrected by the builder, a follow-up survey in 1955 showed very little change in the level of the White House; by 1972, it had subsided only four-hundredths of an inch.

With Donovan looking on, Taylor attaches a bolt into one of the bench cylinders made specially for precision leveling at the White House. The projecting portion of the bolt has been turned so that the outer end is tapered toward a knob on which the foot of the rod can be attached.

Another bench cylinder, placed high on the south wall, necessitates the hanging of a leveling rod by the survey team. Herrick hangs the rod while Rodman William J. Joyner (left), Donovan, and Whitis set up to take measurements. A gardener from the National Park Service helps support the ladder on which Herrick stands. Statistical tests later showed that this mark had subsided slightly relative to another mark near the southeast corner.

Having finished leveling the west wing, the survey team moves to the front of the White House where Charles T. Whalen, Chief of the Vertical Network Branch, plans the next observation schedule with Taylor, Whitis, and Donovan.

With Joyner and Herrick on the rods, Whitis and Donovan begin a series of observations in front of the White House where the marks are set at the base of the pillars.

"Everything was going as scheduled" said Whitis, "until the White House press corps moved in like locusts."

So members of NGS Mobile Field Party G-37 briefly interrupt their work, for "prime time" interviews seen that week on national television.

The next day, the geodetic bench marks located on the walls in the east wing of the White House are surveyed.

And when the job is complete, members of G-37 line up on the south lawn of the White House for obligatory photograph.

Later, at NGS headquarters, Whalen commented on the results of the survey. "During the 1971–1978 period," he said, "there wasn't any statistically significant change in elevation on the north wall. The survey did find a subsidence of about 2 mm in the vicinity of the southwest corner, relative to a mark near the southeast corner.

He said that this subsidence was "statistically significant", and believes that the White House should be carefully monitored in coming years to determine if structural damage may occur.

"But it's very little," he said. After checking his pocket computer, he added: "At that rate of subsidence, it will take 89 years for the southwest corner to sink an inch."

Meanwhile, members of Team G-37 are today scattered about, working on NGS assignments through the U.S. But they will always remember their summer job at the White House.

Stormfury Goes Down Under

By CONSTANCE A. ARNHOLS*

It was Wednesday, February 21, 1979, and Kerry, situated over the Coral Sea at a point 700 km off Townsville, Australia, was about to become the first southern hemisphere tropical cyclone* to be scientifically investigated by instrumented research aircraft. Australian meteorologists and journalists flying toward Kerry aboard NOAA's Orion WP-3D (N42RF) were eager to see the research aircraft's sophisticated weather instruments in action and more than a little curious about how it would be to fly repeatedly straight through a tropical cyclone. Their hosts were members of the NOAA Research Facilities Center (RFC) and scientists from NOAA's National Hurricane and Experimental Meteorology Laboratory (NHEML).

A rough ride lay ahead, but when it was over after 2½ nerve-tingling hours, not only had a weather first been accomplished, but some surprising information had been gathered.

The plan was to run a butterfly pattern of 193-km (120-mi) passes through the eye of the storm at 500 meters to collect near-surface information; than at about 6,000 meters (near freezing level), and finally 8,000 meters. It sounded routine. Then came the test that tries one's stomach. Jim Crawford of the Brisbane *Courier-Mail* gave his impressions. "The buffeting was immediate as we entered the cyclone . . . the up- and downdrafts rocked the aircraft and for fractions of a second, one was weightless. Immediately after, one felt squashed into the seat and then was flung side-ways . . . one gust caught the aircraft at 500 meters and it took the combined strength of two pilots to stop it flipping over."

Chief Scientist Robert Sheets who has flown through hurricanes 150 to 175 times, agreed that Kerry was rough. "On a scale of 1 to 10, I would rate it at about 5 to 7," he said.

Why were these people challenging Kerry?

Events leading up to this and following flights had started about a year beforehand when it was proposed that U.S. and Australian tropical meteorologists discuss the feasibility of conducting tropical cyclone modification research operations over Australian waters. After a NOAA expenditure of $30 million on aircraft and instrumentation, U.S. hurricane researchers are at a stage where conclusive experiments can be conducted. There have been relatively few suitable storms in the Atlantic during the 1970's, but the Australian regions of the Pacific and Indian Oceans have been especially productive, with an average of two to four tropical cyclones per year. The prospect of being able to draw upon Australia's excellent scientific community and of conducting research missions over waters where tropical cyclones often form is attractive to U.S. scientists. Australian meteorologists are equally interested in working with Americans and in adding to their knowledge of these storms.

A visit of United States scientists to Queensland was arranged for February-March 1979 as a first step toward possible cooperative research efforts in the years to come. Included would be briefings and flights in the N42RF, although there would be no actual seeding operations. Everything was well planned, except, of course, the weather. And Nature took care of that detail by creating an appropriate setting composed of two tropical cyclones (Kerry and Rosa) during four weeks of meetings among the weather experts. As a result, scientists flew five monitoring missions (almost 30 hours) into these cyclones and two cloud physics/dynamics missions.

Even as first greetings were being exchanged by U.S. and Australian participants on February 13, Kerry was whirling through the Solomon Islands, taking a course that would lead to the very section of the Queensland coast where the meteorologists were gathering. Soon afterward, Tropical Cyclone Rosa appeared over the Gulf of Carpentaria, which is on the northeast side on Australia. Meanwhile, Kerry continued its acrobatic display of loops and turns in the Coral Sea to the east.

The reason for the meeting of scientists from two nations, occuring in what might be called fortunate conjunction with two tropical cyclones, was Project Stormfury-Australia. Project Stormfury is a NOAA research program designed to test the theory that peak tropical cyclone winds can be diminished by 10 percent to 15 percent through seeding specified areas of the storm with silver iodide. According to project scientists, this could result in a 20 percent to 30 percent reduction in property damages and savings of $50 to $100 million. Although the theory remains unproven, it has a sound scientific basis. Research teams are encouraged by the seeding results obtained from Hurricane Debbie in 1969 where winds reduced by 31 percent after treatment. (Not all of this reduction, however, can reasonably be attributed to seeding.) Twenty-four hours later, after Debbie had regained strength, a 15 percent wind reduction was observed following seeding. Debbie operations set the model for future experiments.

The Kerry flight on February 21 was an excellent beginning to the Project Stormfury-Australia effort. Measurements radioed to Ray Wilkie, Regional Director of the Brisbane Meteorological Office, presented a far different picture of the cyclone than had been deduced from satellite observations. Instead of the expected 75-knot winds, maximum winds of 124 knots were recorded. Winds in excess of 90 knots covered a region more than 241 kilometers (150 miles) across. A central pressure of 960 millibars was measured.

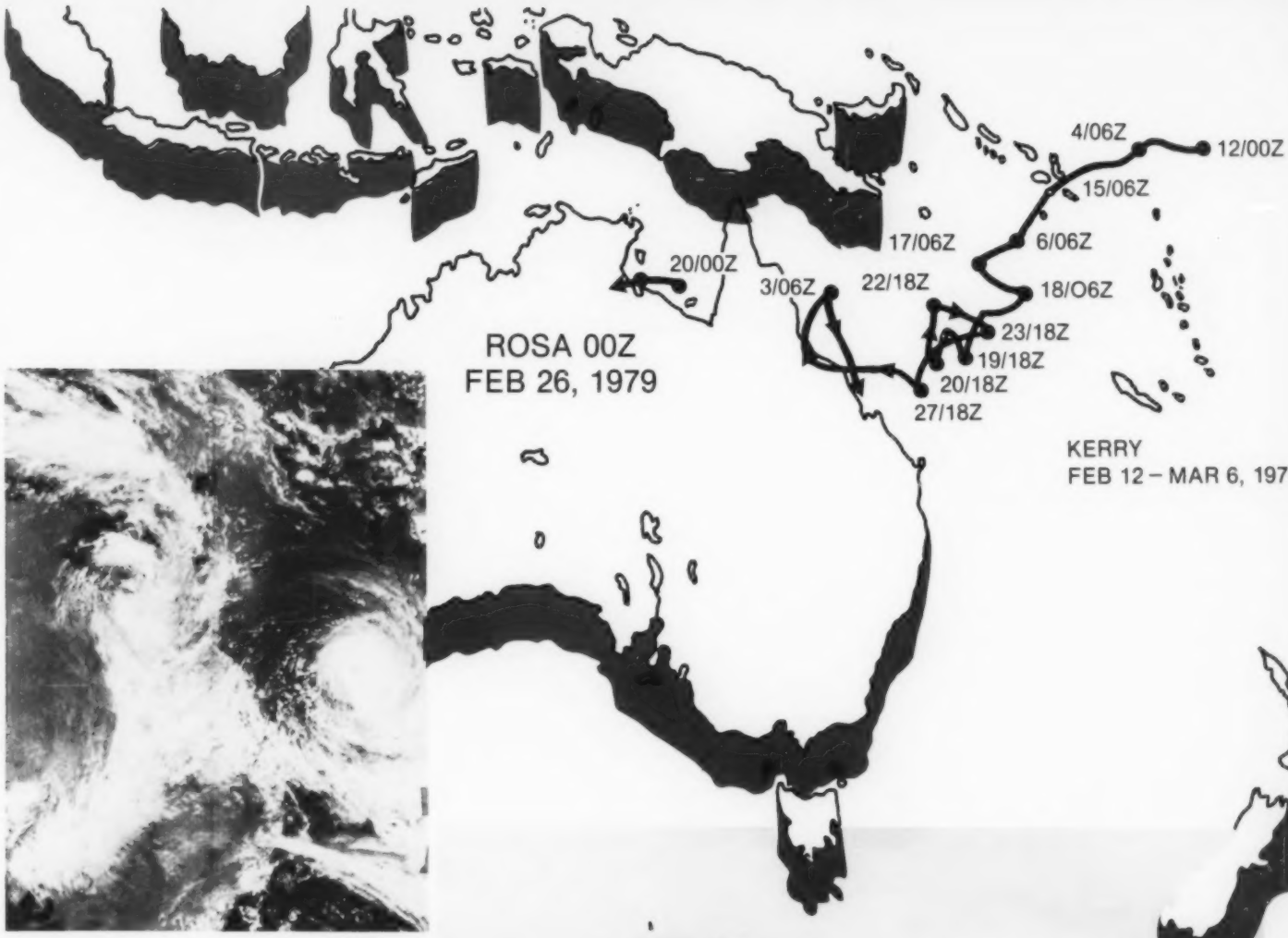
Receipt of the Orion data meant that, for the first time, Australian forecasters had a directly measured, comprehensive data set concerning the strength and distribution of wind fields for a cyclone in their part of the world.

It was clear to Australian meteorologists

Tropical Cyclone (Hurricane) Kerry, photographed by Defense Meteorological Satellite Program in the Coral Sea off Queensland, Australia, made the long convoluted track in the upper right of illustration (opposite page) and was one of two encountered by NOAA's Stormfury-Australia project. Lower photo shows NOAA's Orion at Garbutt Field, Townsville, Australia, before takeoff into Tropical Cyclone Kerry on Feb. 21, 1979.

**A tropical cyclone is a cyclonic whirlpool that forms over the tropical oceans. Names for such storms (with winds exceeding 64 knots) vary according to regions where they are located: severe tropical cyclone in the Australian region of the South Pacific and Indian Ocean; hurricane in the North Atlantic, Caribbean Sea, Gulf of Mexico, and eastern Pacific; typhoon in the Northwest and South Pacific. Northern hemisphere cyclones have counterclockwise circulation; southern hemisphere cyclones have clockwise rotation.*

**Constance Arnhols is a writer-editor with the National Hurricane and Experimental Meteorology Laboratory in Miami*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FEB 26, 1979
KERRY
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that improved warning and forecasting capabilities would be possible through aircraft penetration of threatening storms. Dr. Robert Brock of the Department of Science's Bureau of Meteorology, and Australian Scientific Coordinator for the U.S. visit, was quoted by the *Townsville Daily Bulletin:* "Australian meteorologists have very little information about the actual structure of storms. At the moment, the forecasters have to depend on numerical models based on mathematics. This project will give them data to verify these models."

The second Kerry mission took place on February 22 when the storm was 600 kilometers (373 miles) east of Cairns. On board were: Ray Wilkie (Bureau of Meteorology, Brisbane), John McGann (Officer-in-Charge, Townsville Meteorological Office); Professor Hugh Trollope (Deputy Vice-Chancellor, James Cook University); and Greg Holland (Bureau of Meteorology, Melbourne). They returned with valuable data from what they thought would be the last flight into Kerry.

Meanwhile, a new tropical disturbance manifested itself and within 24 hours developed into Tropical Cyclone Rosa. A 7-hour flight was made through the trailing half of the storm on February 24 when Rosa began to cross an isolated section of the Gulf of Carpentaria. Although no eye penetration was made because Rosa was beginning to cross the coast, excellent radar coverage was obtained of a storm making landfall.

This was the first time aloft in a tropical cyclone for Dr. John Zillman, Commonwealth Director of the Australian Bureau of Meteorology. He described Stormfury as an "excellent initiative" that would give Australia the ability to improve tropical cyclone warnings and forecasting.

Rosa dissipated almost as quickly as it had formed, but Kerry remained a good subject for study. On February 28, the Orion made another flight into this storm at 6,000 meters elevation for collection of landfall data.

At last, attention could be turned to the 3-day Workshop on the Mechanisms of Cyclones (February 28 - March 2) sponsored by NOAA, the Australian Bureau of Meteorology, and James Cook University in Townsville. The purpose was to provide a forum for an exchange of views between visiting American scientists and Australians engaged in tropical cyclone research. It would also help to define the current state of knowledge about cyclone mechanics. An additional benefit, remarked upon at a close of the meetings, was the coming together of scientists from two countries, which would lead to the establishment of personal contacts and future cooperative research projects.

Australians represented the Commonwealth Scientific and Industrial Research Organization (CSIRO) Divisions of Atmospheric Physics and Cloud Physics; Australian Bureau of Meteorology; Australian Numerical Meteorology Research Center; James Cook, University of North Queensland; Melbourne, Monash, and New England Universities; and the Royal Australian Air Force. The United States contingent was made up of NOAA personnel from the three ERL units. Dr. Stanley Rosenthal, NHEML's Director, delivered the opening address in which he described the modeling of hurricane-scale phenomena. Other NOAA speakers covered hurricane dynamics and structure, Project Stormfury, cloud physics, satellite (Seasat) measurements of hurricane wind fields, airborne expendable bathythermograph (AXBT) data on ocean response to moving tropical cyclones, radar measurements in hurricanes, cumulus representation in hurricane models, and use of the aircraft as a research platform.

Nature was not waiting for scientific discussion and analysis to catch up with her, however. On the second day of the workshop, Kerry churned past the port of MacKay, about 300 kilometers (186 miles) south of Townsville, leaving $10 million in crop, livestock, and property damage in its wake before heading inland between Proserpine and Bowen. It seemed as though Kerry would weaken, but on March 2 the storm headed back over water, strengthened, and continued

Clockwise from upper left, participants in Stormfury-Australia included Capt. David Turner, RFC, shown at controls of the Orion aircraft; Dr. Robert C. Sheets, NHEML, Scientific Director of project Stormfury; Dr. Robert R. Brook (l.), Australian Scientific Coordinator for the two-nation effort, and Dr. C.B. Emmanuel, RFC Director; and (at Orion radar console) Prof. Hugh Trollope (foreground), Deputy Vice-Chancellor, James Cook University, and Peter Black of NHEML.

on a northerly course. As the workshop ended, Kerry moved along on its seemingly endless track. In its 18th day, on March 3, the tropical cyclone turned once again, backtracking to the southeast over the Great Barrier Reef resort islands. Newspapers reported washed-out beaches and roads, shattered roofs, closed airports, halted rail service, and massive cleanups. The Brisbane Weather Bureau posted its sentiments with a sign proclaiming "Bury Kerry."

A third Orion mission on March 4 at 500 meters proved to be the eagerly awaited farewell to one of the longest-lasting storms experienced by Australians in a decade. This flight provided data on the re-formation of the storm just off the Australian coast. Land-based radar continually monitored Kerry during this mission while the aircraft provided data for use in forecasts and warnings and for an Australian research effort associated with the relationship of echo motion to wind speed. After this mission had ended, Kerry continued southward and finally dissipated.

Kerry was unusual in the extreme. The most erratic Australian tropical cyclone in 10 years, it had changed direction six times over a 3,000-kilometer (1,864-mile) course that lasted 3 weeks. Winds of 70 meters per second were recorded and, in one sector, winds of 50 meters per second extended more than 200 kilometers from the center. Kerry twice weakened and regained strength, and twice turned north in the hemisphere where such storms characteristically travel south. Small wonder that, in the aftermath, one Australian editorial pronounced Stormfury "one of the most exciting things ever to happen to North Queensland." Further endorsement came from Dr. Hugh Trollope when he said, "It is my great hope that we can continue to gather information in this way through further Australian cooperation in Stormfury and through the development of our own information gathering facility. . ."

Thus, the framework was established for an international study of southern hemisphere tropical cyclones in the 1980's. Should the project go forward, a team of 100 American scientists and support staff and five specially instrumented aircraft would spend about 3 months per year for 3 to 5 years in Australia during the cyclone season. If the start of an effort can be said to set the pace for its future, surely Stormfury-Australia studies are destined to yield significant and beneficial results. □

Stormfury Australia: The NOAA Team

Project Stormfury is NOAA's long-term research project for investigating methods of reducing the destructive forces of hurricanes. Three units of the Environmental Research Laboratories provided staffers to introduce Stormfury to Australian and selected members of the team provided formal and informal briefings aboard the aircraft and on the ground, from Darwin on the northern coast of Australia to Melbourne in the south.

The Weather Modification Program Office sent Merlin Williams.

The National Hurricane and Experimental Meteorology Laboratory provided Stanley Rosenthal, Robert Sheets, Peter Black, Billy Lewis, and Paul Willis.

The Research Facilities Center staff for the trip consisted of C.B. Emmanuel, David Turner, Fred Werley, Harlan Davis, Jim Brown, Jim DuGrannut, Paul Connor, Jim McRory, Larry Rose, Leon Correll, Bill Moran, Hughlon Nunn, Thomas Bergner, Gerald Schissel, and (on contract from Air Tech Service of Miami) Jack Ellwood.

Array of instruments under Orion wing measured cloud particle sizes, shapes, and counts. Dr. John Zillman (foreground in photo at top right), Commonwealth Director of the Australian Bureau of Meteorology, shown with John McIGann, Officer-in-Charge of the Townsville Meteorological Office. At right, Dr. Sheets and Greg Holland, Australian Bureau of Meteorology, conduct preflight scientific briefing of (l. to r.) Prof. Trollope; Ray Wilkie, Regional Director, Australian Bureau of Meteorology; Dr. Mal Heron of James Cook University, and Joe Oost, manager of two Australian radio stations.

Gateway To The Fleet

By LT. TODD A. BAXTER *

The Miller Freeman is bottom-trawling off the coast of Alaska. The Townsend Cromwell is working with porpoises in the South Pacific. The Davidson is sweeping up the West Coast, making hydrographic surveys. The Discoverer is doing exotic science outside Mexican waters.

Scattered over many thousands of miles, undertaking tasks of incredible diversity, utterly different from each other in size, shape and capabilities, these NOAA ships have one thing in common.

They call it PMC.

To the casual observer, PMC—the Pacific Marine Center—is simply a collection of often empty piers located on the eastern shore of Lake Union in Seattle. But to scientists and project managers of NOAA laboratories, universities, and Government agencies, the Center is their gateway to the fleet of research vessels that provide vital data and observations needed to complete their experiments. PMC's purpose is to support and to coordinate the activities of NOAA's west coast research fleet.

PMC and its East Coast counterpart in Norfolk, Va., the Atlantic Marine Center, are responsible for the support of NOAA's 24 vessel research fleet. Thirteen of these ships are assigned to West Coast projects and eleven to East Coast projects. More than 100 commissioned officers of the NOAA Corps—almost one-third of the total strength of this small service—are assigned to the ships and support positions of PMC, and more than 500 civilians crew the ships and work in shoreside positions at the center. The Pacific Marine Center is thus one of NOAA's largest facilities.

Some NOAA ships are designed and equipped for specialized work; others undertake a wider variety of jobs. The task of understanding the complex system that allocates ship time falls to R. Adm. Eugene Taylor, Center Director. "Initial requests for ship time," Admiral Taylor explained, "are sent to the Fleet Allocation Council in Rockville, Md., as much as 3 years before the desired sailing dates. The council weighs the priorities of each request, formulates a master schedule of each season's operations, and assigns projects to the marine centers for detailed planning and incorporation into a ship's sailing schedule."

It is at this point that most project managers first come into contact with the PMC staff. Many hours of work are required to integrate several projects into the movements of a ship without causing conflicts. "We must work very closely with the program people to understand their needs and develop an efficient ship's schedule," said Admiral Taylor. "Meeting the needs of the projects as well as finding time for maintenance, repairs, and other essential needs requires coordination and compromise."

Repair and maintenance represent major considerations in scheduling a ship's time. Most of this work is done during the winter months when the ships return to Seattle. The Marine Engineering and Electronic Engineering Divisions of the center, which are responsible for the equipment and ready condition of the fleet, work all year to prepare for the short winter repair season.

Minor maintenance and repair is carried out in each ship's own machine shop by its skilled crew. The rest is contracted to one of the many shipyards in the Seattle area. As Henry Shek, chief of the Marine Engineering Division, put it: "We do very little repair work ourselves. We are a management facility, though we do have some test equipment for diagnosing problems on the ships. So we arrange for contractors to do the work, because they have the special tools and facilities needed. We have to be flexible in case of emergencies, but we still work well in advance of the ships' predicted repair needs."

No ship is exactly like any other, even a sister ship. Each has special needs and systems that must be understood and dealt with individually. "Each ship is a separate entity," said Shek, "and we assist them on that basis." Each engineer and technician in his group is assigned to specific ships, but each also has one or more specialties on which he is consulted by the others.

Attesting to PMC's ability to solve repair problems in the field is the 9-foot "Bull Gear" recently taken from the main engine of the NOAA Ship Surveyor and installed in front of the Center. The gear failed while the Surveyor was making port in Kodiak, Alaska, and would have put the ship out of commission for a year, until a replacement could have been made, seriously disrupting the projects that depended on the Surveyor. With the help of the ship's engineers and technicians flown in from the East Coast, however, the massive, precision-machined gear was repaired in place and was used successfully for more than a year while a replacement was manufactured. If you look closely you may still see where the broken teeth of the gear were cut back and polished to allow it to operate.

The Electronic Engineering Division includes a large pool of trained technicians who rotate between assignments on the ships at sea and repair work at the center. With greater reliance on electronic navigation systems and data collection systems to provide the quality of information needed for many projects, the Electronic Engineering Division in recent years has increased its preventive maintenance efforts. The division chief, Lt. Cdr. Joe Sowers, noted, "Each winter we completely strip all of the units off the ships and check all the basic systems. We have duplicate systems on board for units that are critical to the safety or operation of the ship. If one system fails, we still have the other to run with."

Most of the electrical systems are also sent to other shops for repair. "As our electronics systems become more complex, we have gone to the modular repair approach," says Sowers. "We send the bad part to the factory. The days of changing a few tubes are gone. Everything is miniaturized or printed circuitry and these are very difficult to repair."

The Operations Division of the Center is responsible for supplying the needs of the ships while they are at sea or in other ports-of-call. For each ship, there is one person in the division who is the contact with PMC. These operations specialists review or write the instructions that give the ship the detailed needs of each project. They also ensure that all support materials, personnel, and necessary information are available before the ship is assigned to a project.

Chief of the Operations Division is Cdr. Darrell Crawford, who recently served as commanding officer of the NOAA Ship McArthur. He is also the support specialist for the McArthur, often referred to simply as the "Mac." He defines the division's job as "to support the fleet technically and logistically. We assist with project instructions, personnel matters, procurement, and administration. In short, we cover what the ships are to do, how

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*Lt. Baxter, NOAA Corps, is Special Assistant to the Director of the Pacific Marine Center in Seattle.

they are to do it, and when they are to do it."

The McArthur is a Class III survey vessel presently equipped for tide and current studies. "This is the opening year of a comprehensive 4-year study of the circulatory systems of San Francisco Bay," explained Crawford. The McArthur will be deploying shallow water current meters to define the current flow of the San Francisco Bay area. This work will complement hydrographic surveys done in the area by the Davidson, Fairweather and Rainier. "The McArthur is is almost self-sufficient," he added, "and is well equipped to do current mooring work. Operations handles the few incidental problems that pop up."

Arranging for mail, pay checks, and scientists with their equipment to be waiting on the pier in some remote port-of-call is a routine function for the staff. James Bryant is the man in charge of the Northwest Administrative Services Office (NASO) Depot, located on the grounds of the Pacific Marine Center. While not administratively part of the center, the NASO Depot is essential to supplying logistic support to the fleet. The "warehouse," as it is commonly referred to, is the kickoff point for the thousands of pounds of equipment and supplies that are shipped to the fleet each year. "Some of the areas that we ship to are remote," says Bryant, "and usually the equipment we are shipping is urgently required. We have made many emergency shipments to hard-to-reach places."

One such shipment occurred in 1976. The Marine Engineering Division had to ship a half-ton steam condenser to the Surveyor, which was disabled in Dutch Harbor, Alaska. Since crane and pier facilities were lacking in this tiny Aleutian Island port, the Surveyor had to use its helicopter to lift the condenser into one of the ship's boats for the trip out to the ship, at anchor in the harbor. "We were sure that we could get the condenser to Dutch Harbor," said Bryant, "but after that we had to rely on the ship's ingenuity to get it aboard."

Payroll and timekeeping may seem routine, but having a pay check waiting when you reach port is one of the most important morale factors for the people who sail NOAA's fleet. Jack Brett, the marine center's budget officer, is responsible for seeing that this happens. "We constantly monitor the ships' movements with the help of Operations Division," he said, "so that we can have the paychecks waiting when a ship ties up, no matter where it may be."

The Budget Office also provides guidance to the ships. Providing the food, fuel, equipment, and people required to keep these "floating cities" at sea and operational is complicated and expensive. "Each ship is given an operating budget based on the ship's needs and operation," Brett explained. "Sometimes an emergency will arise and we have to pass money from one ship to another to cover the situation. We try to let the ships manage their budgets as much as possible, and help them when they need it."

Of the 10 ships that operate out of Seattle, three are actively engaged in supporting programs of the National Marine Fisheries Service.

One of them, the Miller Freeman, is the largest stern trawl research vessel in the United States. She and the other fisheries ships put in some of the longest field seasons of any ships in the fleet. "Right now the ship is bottom-trawling on the Shelf of Alaska," said Bob Hitz. "After a short stop in Seattle, she will go to the Bering Sea to do some midwater trawling. This will be a mixture of fisheries and oceanographic work. Right now the projects are really meshing together. They are using the same ship at the time for two separate projects and it is working out quite well."

Three other NOAA vessels working in the Pacific are supported by the center, but seldom come into Seattle. They are the David Starr Jordan, the Townsend Cromwell, and the Murre II, with home ports closer to their working grounds.

Bob Hitz has been with PMC since 1972 as an operations specialist supporting those vessels assigned to NMFS projects. "The type of support needed by various ships differs quite a bit because of the projects and size of the ships," said Hitz. The larger vessels, like the Miller Freeman, are comparatively self-sufficient, especially in administrative and personnel matters. The smaller vessels such as the Oregon or John N. Cobb need more logistic and administrative help since there are only four or five people on board to do all the work."

The Townsend Cromwell, home port Honolulu, is working in the eastern tropical Pacific. Though she seldom comes to Seattle, the ship

The Pacific Marine Center, Lake Union, Seattle, and part of the NOAA fleet assigned to West Coast projects.

still receives much of her operational support from the Pacific Marine Center. "They have just finished a cooperative operation in in the South Pacific monitoring the tuna/porpoise interactions," says Hitz. Two NOAA Corps officers assigned to the Southwest Fisheries Center, Lt. Terry Jackson and Lt. Cdr. Wayne Perrymen, have been active in this project. "They have used the Cromwell and Jordan in combination with an aircraft to follow the tuna/porpoise schools," said Hitz. "Now the Cromwell is doing a complete biological resource survey in the Northern Hawaiian Islands. The Monk seals in that area are considered an endangered species, and the bird populations are also receiving increased attention.

"Later this year the ship will go to the Trust Territories in the South Pacific and as far west as Japan," he continued. "The Townsend-Cromwell probably covers more miles than any ship in the fleet, as she sails all over the South Pacific."

Hydrographic surveying is one of the traditional projects of NOAA. Accurate hydrography is especially important today as more and larger vessels use our inland and coastal waterways. The marine center devotes a sizable portion of its resources to the support of hydrography, and three ships attached to the center work on West Coast hydrographic surveys—the Davidson, the Fairweather, and the Rainier.

The operations specialist responsible for supporting these vessels is Lt. Cdr. David MacFarland. Many of the tasks MacFarland performs for his ships are similar to the work of the other support specialists, but there are also special needs. For example, there are few sources of trained hydrographers, so NOAA must train the men and women who will be doing this vital work. Lt. Cdr. MacFarland and Lt. William Wert are the instructors in PCM's intensive 6-week course in hydrographic surveying. Before they are sent to the fleet, young officers with the necessary backgrounds in engineering or one of the natural sciences, are put through the long hours and hard work that it takes to make a hydrographer. This training program is becoming so successful that the Navy has sent several of its officers to attend the course.

Instructions for hydrographic projects are important both to the ships and to the shore-side project personnel. The Operations staff gathers all of the control data, tide data, presurvey review items, and does most of the detail work, so that when a ship receives its projects, the work is well defined and within its capabilities.

"If they run up against a problem or situation at sea that they cannot handle, we give them the answer over the radio or find someone who can help them," MacFarland said. "When the ships are at sea it is hard for them to reach people, and we try to do that for them. When someone out there gets sick we follow the situation and keep their families informed. We provide assistance if it is needed. We try to provide a total service to the ships and to the people in the fleet."

Hydrographic surveys—often referred to as "hydro"—are being conducted now in Alaska, California and Hawaii. Alaskan waters have received a great deal of attention since the "Good Friday" earthquake of 1964 invalidated many of the previous surveys of that region. With increased vessel traffic due to the opening of the Alaskan oil pipeline, the need for accurate navigational charts is even more pressing.

Above, a fork lift is taken aboard the Discoverer. Top left, Ensign Teresa C. E. Bowles conducts school children on a tour of the NOAA Research Vessel Discoverer. Top right, Commander John P. Vandermeulen with a tour group on the bridge of the Discoverer.

Roger Ankey handling teletype and voice traffic at the NOAA base radio station at the Pacific Marine Center.

Unlike other divisions at the Pacific Marine Center, Processing Division supports a specific project—the hydrographic survey. Raw data from the fleet is sent to the Processing Division where it is put through a concentrated quality control process before the survey is sent to Rockville for inclusion into the latest nautical charts.

Larry Mordock, formerly a NOAA commissioned officer, is the systems engineer of the computer support group in the division. "In the old days hydrography was as much art as science," he explained, "with all position and depth data being recorded and plotted by hand. The Hydroplot System now in use is an automated data logging system that allows the computer to note the launch's position, the depth of the water and other information as the boat moves through the water." The computer also controls a small plotter on the launch which produces the "boat sheet," a real time plot of the soundings and the first step in producing a chart.

The hydrographic data collected in the field is then sent to the marine center for processing and verification. Jim Green, chief of the Verification Branch, explained: "Verification is the 'people part' of the processing. The data is first reviewed by a verifier for obvious errors, such as 25 hour days or negative depths. These happen occasionally, usually due to 'burps' in the mechanical digitizing systems. Then we look for more subtle errors of judgment such as incorrect line spacing or not developing a shoal area. After the initial review we have a series of interactions with the computer/plotter section to refine the data, select the best soundings for addition to the chart and add such details as shoreline, depth contours, and topographic detail."

The end result is that, although only one out of every one hundred soundings appears on the finished chart, it is the one that is the most accurate and representative of that general position. If any errors are made, they are conservative and on the side of safety.

The computer at the Pacific Marine Center is an impressive array of computing systems that is constantly being improved and upgraded as new technology becomes available. Although it takes about a year from the time a survey leaves the ship until it is incorporated into the latest chart, this is an improvement over previous years, made possible by the introduction of computerized data systems and automated plotting equipment. "With the computer it is possible to review thousands of bits of data in a fraction of the time it would take to do the same thing by hand," Mordock said.

Another advantage of having an entire survey stored on computer tape is the wide variety of uses to which it can be put. "A hydrographic survey is really an engineering manuscript, and can be used by developers, coastal zone managers, oil companies, and many other groups," Mordock noted. "As the use of computer-translated data becomes more common, other users will be attracted to this source of information about the ocean floors."

Fairweather and Rainier, 231-foot sister ships, have been surveying Cook Inlet, the main passage to the port of Anchorage. "There has been a big push to finish the Cook Inlet surveys, which we have been working on since 1964," says MacFarland. "It has been a continuous steady effort, but the area is huge—a vast expanse of water and shoreline. We project that the surveys will be finished in the 1980's."

Because of the bad weather in Alaskan waters, the ships are able to work only during the summer months. "We have other projects for the ships when the weather is too foul to work up there," said MacFarland. "Like Alaska, the southern coast of California has received much attention in recent years, with major surveys completed last year."

After several years of inactivity in the Hawaiian region, NOAA vessels are now resurveying that area. "This is another ongoing project for the Fairweather and Rainier," noted MacFarland. "They will be working the southern coast of the big island for the next few years—Fairweather in the spring and Rainier in the fall."

The Davidson, 175-foot sister ship of the McArthur, is working on surveys of San Francisco Bay and several areas in Alaska, including work in Prince William Sound surveying the approach to Valdez, the terminus of the Trans-Alaskan Pipeline.

The three Class I vessels at the Pacific Marine Center are the Oceanographer, Discoverer, and Surveyor. George Fernandes follows their progress from the confines of the marine center. "These ships are capable of carrying out several projects at once, due to their large size," he said. "The Discoverer and Surveyor have been doing combined operations in Alaska, working on the Outer Continental Shelf Environmental Assessment program (OCSEAP). This includes studies for NMFS, Pacific Marine Environmental Laboratories (PMEL), NOS and other agencies. This year their work is even more varied with the Discoverer leaving her usual Alaskan working grounds and going on a special project near Mexico. The Surveyor, with her helicopter, will continue to work in Alaska and the ice pack of the Bering Sea."

The Oceanographer is working with an ongoing seven year project—the Deep Ocean Mining Environmental Study (DOMES). "The push here is to understand the environmental changes that could result from the mining of manganese nodules from the ocean floor," said Fernandes. "Last year three companies started test mining operations, and the Oceanographer was there to monitor and sample the discharge of bottom sediments into the upper water layers."

One reason the center can deal so effectively on behalf of the fleet while it is at sea is the base radio station, operated by Roger Ankney. Originally equipped with surplus equipment from the ships, it is now being modernized and some of the older equipment is being replaced.

Roger Ankney discussed the operation of his station. "The Navy or Coast Guard stations cover all emergency and rescue traffic, but we provide a fast and reliable means of communication between the center and the fleet," he said. "We pass payroll data, time and attendance, and other operational requests using the radio-teletype mostly, though at times we open a voice channel so people can talk."

Two large trailers at the center are headquarters of the Pacific Tide Party, a group that provides tide data for the many projects coordinated by the center and for the published tide tables. The party maintains 55 permanent tide stations and several temporary tide gages located throughout the Pacific basin. Officer in charge Lt. Greg Segur and his assistant, Lt. (j.g.) Fain McGough, do a portion of the traveling and installation work on the gages. "We go from the tip of the Aleutians, down through Alaska, down the West Coast, out to Hawaii and as far east as Guam," said Segur.

One of the group's most challenging tasks is shipping hundreds of pounds of delicate, expensive equipment into some of the most remote places in the Pacific. Once on the site, Segur and McGough must use talent, training, and ingenuity to install the gages. "Take construction under water," said McGough. "We are still learning new ways to install the float wells. There is no such thing as a manual of tidal data collection. It is all learned on the job because each tide station is unique."

There is a good cooperative spirit between the tide party and the ships. "We sometimes provide tidal data to the ships doing hydro," said Segur, "so that they can correct their sounding data. They help us by transporting our gages to inaccessible areas." McGough added, "We also provide the ships with equipment and technical advice when they need to set up their own gages." Tide party staffers also teach a class on the tide gage for ships' crews.

The best way to sum up the feelings of the people who work at the Pacific Marine Center is to follow them to the pier and listen to the comments that are made as the last ship of the season pulls away from the pier and heads for the open sea. Some may express relief that a busy time of the year has passed. Others will miss the activity, the old friends and shipmates that they see too infrequently. Some may wish that they too were aboard ship, heading out to sea and some new project. But they all have one thing in common—their interests and working lives revolve around the ships of the NOAA Pacific Fleet. □

Cleaning Up The Brown Cloud

By RICHARD E. NEWELL

In 1661, the Englishman John Evelyn put forth some practical ideas for easing the London pollution problem. In his 41-page "Fumifugium: or, The Inconvenience of the AER and SMOAKE of London Dissipated," he suggested that chimneys be made taller and pollution sources be moved 5 or 6 miles out of town, with consideration for topographic features and prevailing winds.

Some two centuries later, another concerned writer pointed out that the polluted fogs of London were more than an inconvenience—they were taking lives and damaging property. He recommended that coal fires be replaced by gas heating.

These were among the first serious attempts to cope with air pollution, which we now deal with through systematic work in meteorology, site selection strategy, and emission control. NOAA's Environmental Research Laboratories are working to advance these key elements in the modern push for environmental protection along the Front Range of Colorado's Rocky Mountains.

The Front Range, at whose base lies ERL's Boulder headquarters, is the scene of one of the most serious air pollution problems in the nation. Area residents put air pollution ahead of crime and inflation as their major concern. NOAA and other scientists are planning for the Front Range the most intensive investigation of air pollution ever attempted.

The cities along the Front Range make up a 125-mile strip of rampant urbanization, all centered on a Denver area population of one and a half million people. On high-pollution days, the grandeur of the Rockies is blotted out by the "Brown Cloud," the visible manifestation of the noxious, stagnant air mass that brings three times as many cardiovascular cases to Denver General Hospital as appear on normal days; chest pains and breathing problems are higher then, too.

Los Angeles is still the smog capital of the United States, but runner-up Denver seems to be trying harder. Among the nation's major cities, it has the highest number of automobiles per person, leads in miles driven per car, and has the fewest riders per trip. And the booming Front Range population means that more cars and more industry are on the way.

The area's major health-related air pollutants are carbon monoxide in the winter and ozone in the summer. Carbon monoxide is a colorless, odorless gas that can seriously affect the heart and brain by reducing the amount of oxygen in the bloodstream. Studies have shown that the automobile is the primary carbon monoxide producer. Although cars are much "cleaner" today then 10 years ago, the carbon monoxide threat is much greater at Denver's mile-high altitude than at sea level: in this thin air, incomplete fuel-burning causes car engines to throw out twice as much carbon monoxide, yet the human body is only half as tolerant to it—it's a one-two punch that is unmatched anywhere else in the country. To compound the problem, a recent study showed that angina pain in Denver residents can occur at carbon monoxide levels as low as 5 parts per million (ppm)—significantly below the existing Federal standard of 9 ppm that was exceeded on 125 days in the heart of downtown Denver in 1978.

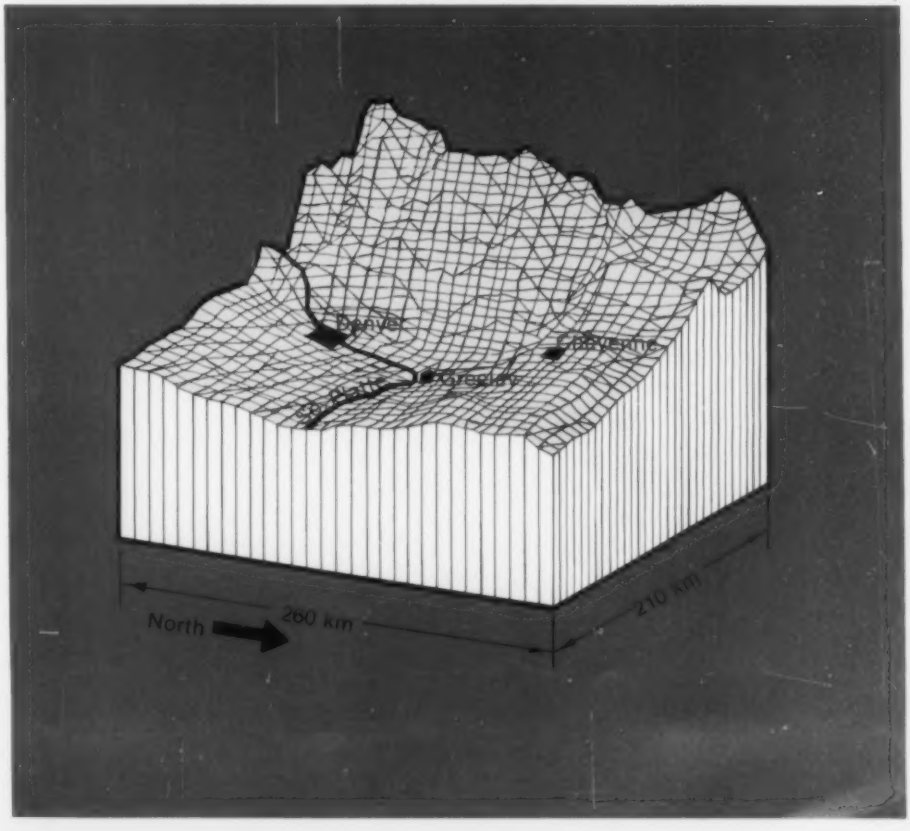
The other major culprit is ozone, also invisible, which can seriously irritate the eyes and lungs. Ninety percent of the world's ozone is produced in the stratosphere, where it shields living things from intense solar radiation. Up close, however, it is intolerable at levels as low as 1 ppm. In the Denver area it is probably near the upper limits for good health, with peak summertime levels of .16 ppm, well above the national standard of .12 ppm. In addition to its effect on human health, ozone poisoning also weakens and stunts the trees and plants around Denver, as it does around many other major cities.

Ozone and other irritating gases are produced by the action of sunlight on automobile and industrial emissions as they blow over the suburbs. Lack of strong sunlight keeps ozone levels low in winter. It also minimizes the warm-air updrafts that would disperse the pollutants that are more abundant. As a result, the winter sky is often brown with smoke and its chemical derivatives from vehicle tailpipes and industrial chimneys—as well as with sand and dust particles stirred up by traffic. The Brown Cloud's particular hue is quite variable, depending on particle concentration and viewing angle with respect to the Sun—when viewed toward the Sun the cloud may even appear white.

Aesthetics aside, the Cloud's particulates can cause breathing problems and respiratory illness. This health threat, and the more serious ones linked with ozone and carbon monoxide, are repeated with certain variations throughout most of the nation's urban areas. The associated public outcry and federal "clean-air" laws help to explain why nearly $15 billion was spent to clean up the Nation's air in 1978 alone.

Along the Front Range, complaints about declining air quality have prompted more than 100 studies by Federal, state, and local governments, as well as by private industry and environmental groups. The first coordinated study of Denver air pollution was made in 1973, and scientists of NOAA's Atmospheric Physics and Chemistry Laboratory have studied it intermittently since then. For one month during November-December 1978, the Laboratory participated in the first intensive study of Brown Cloud chemistry, sponsored by the Motor Vehicle Manufacturers' Association and directed by an independent, private research group.

Dr. Rudolf Pueschel, head of the Laboratory's Atmospheric Chemistry Program Area, explains that, unlike the study of 1973, this one included intensive airborne probes. Two twin-engine aircraft, including the Aeolus, and Aero Commander operated by the Laboratory, flew along predetermined grid tracks over the city at altitudes as low as 500 feet (150 meters). "It was because of our aircraft capability that we were invited to participate in this particular study," said Dr. Peuschel. "We'd been conducting atmospheric chemistry studies from aircraft for the past 5 years."



Left, the "Mile High City" of Denver on a smoggy winter day. Right, cold winter air from the east topped by warm air from the mountains clamps a thermal lid on vehicle and factory emissions giving Colorado's Front Range some of the dirtiest air in the nation.

The NOAA project scientist was research chemist Charles Van Valin. One of his tasks was to secure permission from the Federal Aviation Administration to conduct flights below the 1000-foot (300-meter) level. This waiver was necessary to be sure of penetrating the pollution plume, which usually extended from ground level up to heights of 500-700 feet (150-200 meters). The request for the FAA waiver was 55 pages long and included letters of concurrence from leading officials at all levels of government. "Getting permission to fly at low altitudes was one of the most important aspects of the project," said Van Valin. "It will considerably increase the validity of our scientific results."

One of the key people involved in collecting the data was electrical engineer Dennis Wellman. He helped build and install the instruments and served as operations chief of the Aeolus during the flights, briefing FAA personnel on each day's planned activities and deciding whether from a scientific standpoint the operation was "Go" or "No go."

The project area is near the central business district, freeways, railroad yards, power plants, and several industrial pollution sources. Furthermore, explained Wellman,

Above, researchers check the electric field sensors of Aeolus. (left to right) Dr. Rudolf Pueschel, William Cobb, and Dennis Wellman.

Below, the heavily instrumented Aeolus flew as low as 500 feet over Denver and 200 feet above rural areas studying the city's air pollution late in 1978.

Atmospheric physicist William Cobb checks data collection aboard the Aeolus. Instruments measure air temperature, moisture, conductivity, particle size and distribution, and the concentration of various gases.

"It's in the Platte River Valley, so that the aircraft could descend into relatively shallow pollution plumes while maintaining 500 feet AGL (above ground level)." When the smog hung even lower, the aircraft could still penetrate the trails of warm buoyant fumes that arch above all the major streets and highways like a gridwork of molehills, pushed up from the main plume by the busy traffic below.

"We followed our standard flight tracks in the same direction each day, in order to make more meaningful day-to-day comparisons," Wellman said. "Although the results aren't fully analyzed yet, we are able to identify some of the power plant contributions rather easily, because of our experience with that type of plume." Wellman has flown many hours studying plumes from fossil-fuel-fired power plants in such places as New Mexico, Montana, and Pennsylvania—experience that proved helpful in the Denver Brown Cloud study, where a primary aim was to find out how much pollution comes from cars and how much from industry.

"In the past, nearly all the visible pollution was blamed on automobiles," said Wellman, "but we found out that industry also contributes significant amounts." As Pueschel put it, "The observations branding the automobile as the culprit were made at ground level, near heavy traffic. A comparable but opposite bias would occur if we had only taken measurements directly above industrial smokestacks."

Perched on the nose of the Aeolus last winter was a key instrument for early detection of those charged power plant plumes—an electric field sensor provided by NOAA researcher William E. Cobb. He used a similar device at Hawaii's Mauna Loa Observatory in 1960 and 1968, on the global voyage of the NOAA ship Oceanographer in 1967, and at the Amundsen-Scott South Pole Station in 1977. Cobb is now using 12 years of local data, collected from a hilltop instrument site in Boulder, to estimate long-term changes in the concentration of suspended particulates—the airborne debris that makes up a major share of Front Range pollution. These are among the longest-running pollution records in the area.

"Not all pollution particles carry an electric charge," Cobb said, "but I can monitor them indirectly by measuring air conductivity. That measurement depends on the concentration of small, mobile ions. Since ions tend to be swept up by the bigger particles, a drop in conductivity indicates a greater number of large particulates.

"The records show a 12-year downward trend that's strongest during winter, when our pollution is most severe." he continued. "There are times when the air is as clean as it's ever been, but those times are fewer and farther between."

That's the story all along the Front Range. According to Dr. Pueschel, "The Denver metropolitan pollution study was first-rate, but had it been our own project, we would have gone beyond the city limits. The Denver area's pollution problem is no longer local, but regional. Every city on the Front Range is affected." He and many others see a compelling need to study the problem as a whole.

In fact, he recently helped to plan a study. Besides putting a price tag on the Brown Cloud in terms of health-related social costs, this Denver Regional Air Pollution Study (DRAPS) would, if carried out, serve as the basis for a modern-day "Fumifugium," setting forth the best way to go about cleaning up the "AER and SMOAKE" of the Front Range.

Since controlling air pollution is as much a political process as it is technical, the final DRAPS goals will reflect the values of citizens and policy-making groups, and its results would fit directly into Colorado's pace-setting State Implementation Plan for meeting Federal air pollution standards. The proposed 3-year study would be a well-coordinated regional experiment, conducted by NOAA with the cooperation of the U.S. Environmental Protection Agency, the Colorado State Health Department, the National Center for Atmospheric Research, and nearby universities.

Data would be collected all along the Front Range at ground level and vertically, at least to the top of the pollution layer. The existing network of sensors would be expanded in cooperation with NOAA's new Prototype Regional Observing and Forecasting Service (PROFS), now being established in the Denver area. Towers already existing in the region, including the 300-meter instrumented tower of the Boulder Atmospheric Observatory, would be supplemented by radiosondes, tethered ballons, and rooftop installations.

Remote sensors to be used include Doppler radar, as well as sensors that use pulsed sound energy (acoustic sounders) and pulsed laser energy (lidars) in radar fashion; these will obtain information about low-level wind, temperature, and particle distribution. The project would also use four aircraft, a helicopter, and, to measure the downstream characteristics of the pollution plume, a free-floating, manned balloon.

The aim of the study is to measure not just the pollutants, but how they interact with their environment. The Front Range owes its bad fortune to the fact that, like Los Angeles, its population has grown so large that its noxious emissions can no longer be cleansed by weather and topography.

Earlier studies have shown that wind speed is the main factor controling onset and ending of pollution episodes: a light wind, or a wind from the east that backs up against the Rockies, results in increased pollution. But the strength and height of temperature inversions also have a great deal to do with air quality. Smoke normally rides its warn air upward, gradually dissipating and blowing away. But when the air aloft is relatively warm, it acts as a thermal lid. A light wind and a low, strong inversion offer pollutants no avenue for escape.

The Rocky Mountain barrier to the west helps both to make pollution episodes worse, and to end them. Often the mountains interact with weather systems to set up a strong downslope wind that quickly ventilates the Front Range, creating a mountain view that is especially sharp and beautiful. But sometimes the mountain winds override cold air near the ground. The mountain air is compressed and warmed during its downward flow, reinforcing and sometimes lowering an existing temperature inversion. When this happens, pollution is trapped next to the ground.

Such inversions, made up of a cold surface air layer and warm upper air layer, occur on about 85 percent of fall and winter days. Since the Sun's rays are weak at that time of year, the surface doesn't warn up enough to wipe out the inversion. And so it is that the Brown Cloud haunts the Front Range most frequently during those months.

Whatever the season, mountain waters can play as big a part as mountain winds in trapping pollution. The South Platte River plunges from the Rockies to run from about 80 kilometers south of Denver to 80 kilometers north, before veering eastward. The river drainage basin has a major effect on surface wind flow and air quality in the area: when wind and inversion conditions are right, the pollution from nearby highways and industries becomes trapped within the basin and sloshes up and down the valley, in phase with the nightly cold air drainage down the mountain slopes and the afternoon air-flow back up the heated foothills.

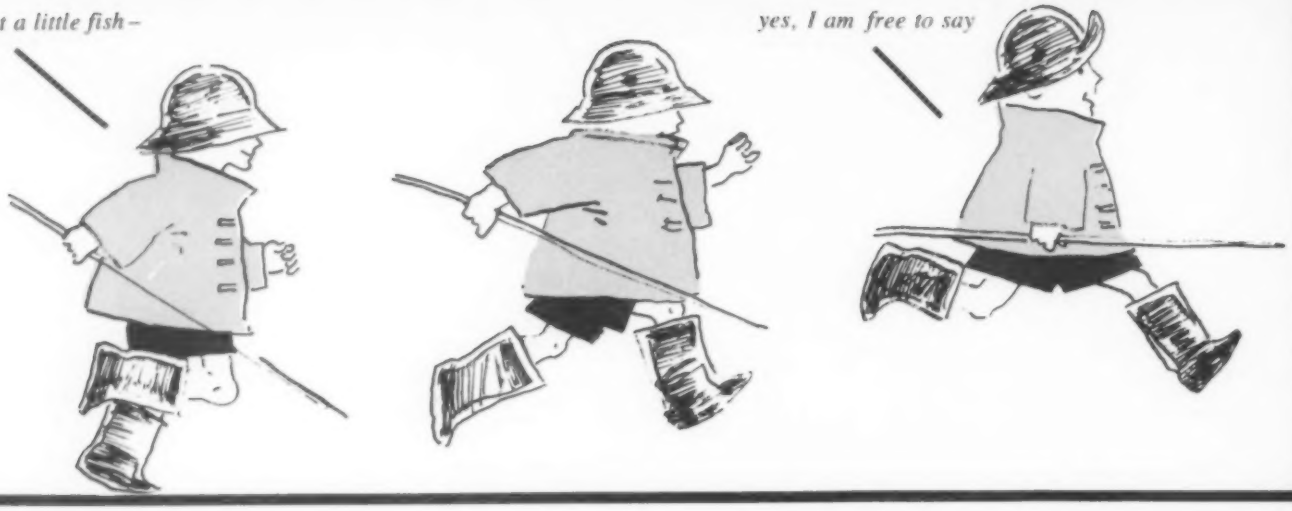
Scientists haven't yet charted all the meanderings of the main Denver pollution plume, nor of the pollutants from cities to the north and south which are probably contributing. Although some important steps to curb Front Range pollution are being taken, the big picture of the Brown Cloud's makeup, behavior, and impact is still being sought. NOAA's proposed Denver Regional Air Pollution Study is designed to provide the hard data needed to identify the control measures that will be most effective in the high-growth years ahead. □

THE VIEW FROM SPACE

These images, obtained from five geostationary satellites which ring the Earth from their positions 22,000 miles above the equator, show the Earth as it appeared on April 15 of this year. Three of the images (Numbers 1, 2, and 4) are from U.S. satellites operated by the National Oceanic and Atmospheric Administration (NOAA). Number 3 is from the European Space Agency's "Meteosat," and Number 5 is from Japan's GMS "Sunflower" satellite. All five of the satellites were launched by NASA. □

I never lost a little fish–

yes, I am free to say

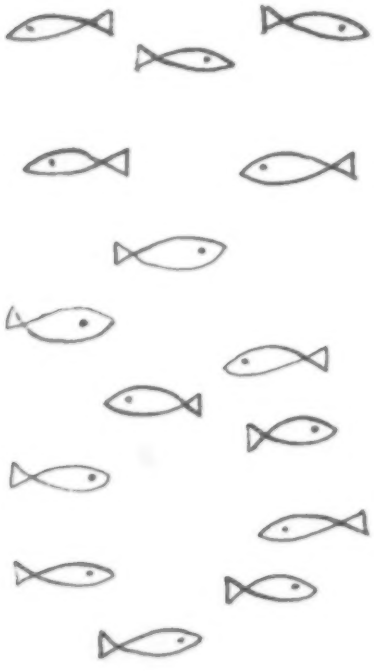


TASTY TRAVEL TIP:

Sea Fare

Even if you've lost your biggest fish, little fish can go a long way with flavor, nutrition, and your budget . . . not to mention all the places they've been to where dishes have been named after them.

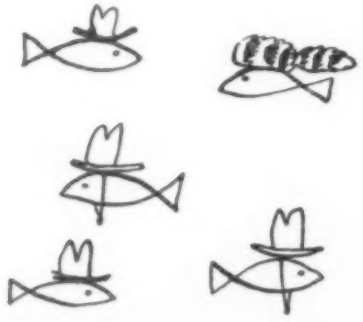
For your cooking pleasure we present recipes of a little fish that goes a long way.



Texas Tuna As You Like It

- 1 can (9¼ ounce) tuna in oil
- ¾ cup chopped onion
- ½ cup chopped celery, optional
- ¾ cup catsup
- ¾ cup water
- 1 tablespoon sugar
- 1 tablespoon vinegar
- 1 tablespoon Worcestershire sauce, optional
- 1 teaspoon prepared mustard
- ¼ teaspoon salt
- Dash of pepper
- 4 servings seasoned cooked rice, noodles, spaghetti or cornbread squares or 6 to 8 hamburger buns

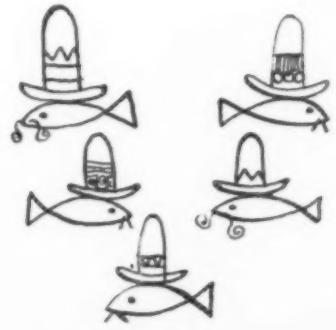
Drain tuna; pour oil into saucepan. Flake tuna. Cook onion and celery, if used, in tuna oil until tender, but not brown. Add remaining ingredients, except tuna. Simmer uncovered about 10 minutes until flavors are blended. Fold in tuna and heat. Serve on hot seasoned cooked rice, noodles, spaghetti or cornbread squares as an entree or on plain or toasted hamburger buns. Makes about 3 cups tuna mixture, enough for 4 dinner-size servings when served on rice, pasta or cornbread or 6 to 8 sandwiches when served on hamburger buns.



Mexican Fish with Beans and Rice

- 1 pound fish fillets, fresh or frozen
- 1 cup chopped onion
- 2 tablespoons margarine or cooking oil
- 1 tablespoon flour
- ½ teaspoon salt
- Dash of pepper
- 1 can (1 pound) tomatoes
- 2 tablespoons brown suger
- 2 tablespoons vinegar
- 1 teaspoon prepared mustard
- 1 can (1 pound) kidney beans, drained
- 1½ cups hot cooked rice

Thaw frozen fish; cut into 1-inch pieces. Cook onion in saucepan in margarine or oil until tender, but not brown. Stir in flour, salt and pepper. Add tomatoes, brown sugar, vinegar and mustard; mix. Simmer uncovered about 10 minutes, stirring frequently. Add fish; simmer about 10 minutes or until fish flakes easily when tested with a fork. Stir kidney beans into hot rice; heat slowly until beans are hot. Serve fish over beans and rice. Makes 4 servings.



It always was the biggest fish *I caught* *that got away.*

(Eugene Field, 1850–1895, ***"Our Biggest Fish,"*** *stanza 2)*

TRY A LITTLE FISH

Individual Maine Sardine Pizzas

- 3 cans (4 ounces each) Maine Sardines
- 6 hamburger buns
- 2 tablespoons butter or margarine
- ¾ cup catsup
- 1 tablespoon chopped onion
- ¾ teaspoon oregano
- Dash garlic powder
- ½ cup grated cheese

Drain sardines. Break into large pieces. Split rolls and spread butter on each half. Place rolls, butter side up, on a cooky sheet, 15 × 12 inches. Distribute sardines equally on each half roll. Combine catsup, onion, oregano, and garlic powder. Place approximately 1 tablespoon catsup mixture over sardines. Sprinkle cheese on top. Bake in a very hot oven, 450°F., for 8 to 10 minutes or until cheese melts and rolls toast. Serve hot. Serves 6.

Manhattan Fish Soup-Stew

- 1 pound fish fillets, fresh or frozen
- 1½ cups sliced carrot
- 1 cup water
- 1 can (10½ ounce) condensed cream of potato soup
- 1 package (9 ounce) frozen cut green beans, thawed
- 1 can (10 ounce) tomatoes
- 1 cup undiluted evaporated milk
- 1½ teaspoons onion salt
- ¼ teaspoon leaf thyme

Thaw frozen fish; cut into 1-inch pieces. Combine carrot slices and water in saucepan; cover and simmer about 15 minutes or until carrots are almost tender. Stir in potato soup, green beans, tomatoes, milk, salt and thyme; heat until hot and bubbly. Add fish: cover and cook about 10 minutes or until fish flakes easily when tested with a fork and beans are done. Serve with hot biscuits, crackers or crusty bread. Makes about 7 cups, 4 dinner-size servings.

Tuna and Noodles, Italian Style

- 1 can (9¼ ounce) tuna in oil
- 1 cup sliced celery
- ½ cup chopped onion
- 1 can (1 pound) tomatoes
- 1 can (6 ounce) tomato paste
- ½ cup water
- 1 teaspoon sugar
- 1 teaspoon garlic salt
- 1 teaspoon oregano
- ½ teaspoon crushed sweet basil
- 4 ounces medium noodles, cooked and drained (about 3 cups uncooked)
- ¼ cup grated Parmesan cheese

Drain tuna; pour oil into saucepan. Flake tuna. Cook celery and onion in tuna oil until tender, but not brown. Add tomatoes, tomato paste, water, sugar, garlic salt, oregano and basil. Cover and simmer about 30 minutes or until flavors are blended. Fold in tuna. Spread ½ of the noodles over bottom of shallow 1½-quart casserole; top with ½ of the tuna mixture and cheese. Repeat using remaining ingredients. Bake in moderate oven, 350°F., about 30 minutes or until hot and bubbly. Makes 4 servings.

noaa/update

NOAA Committed to Study Campeche Oil Spill

The National Oceanic and Atmospheric Administration (NOAA) plans to commit at least an additional $700,000, and perhaps as much as $1 million, in a study assessing the present and long-term impacts of Campeche oil spill on the fragile coastal ecosystems of South Texas, NOAA Administrator Richard A. Frank announced upon his return from a visit to the oil spill site and to Port Isabel, Tex.

"Scientists from NOAA and other agencies have been attempting, by innovation and improvising with the latest technologies, to mitigate the effects of the oil spill through computer forecasts and modelling studies of the Gulf of Mexico currents, including satellite, aerial, and ocean surface surveillance, fisheries advisories, vulnerability studies, and the like," Frank said.

"The full scale of that effort is an outstanding improvisation of talent and technology in a dynamic, threatening, and only partially understood situation," he said. "Now we are undertaking a new program to determine what the effects of this record-breaking spill have been and will be on the life and environment of the area.

"We enter this new stage because the long-term impacts of this oil spill pose serious threats to a variety of on-shore and off-shore life," Frank emphasized, adding, "We are now dealing with an environmental insult on an immense scale, requiring a new dimension of study and attack."

The new study will send 100 researchers into the field to tally the impact of Mexican oil along the South Texas shoreline. While the study will focus primarily on the impact upon wildlife and environment—from bird counts and fish sampling to habitat studies and beach morphology—Frank said it will also examine the socio-economic impacts of the spill; for example, the impact of curtailed tourism on Padre Island and the effect on the fishing industry.

In addition, the NOAA Ship Researcher—one of the agency's major ocean-going research vessels—was directed from other projects to conduct a systematic study along the boundaries of the slick, from the well site northward into U.S. coastal waters. The voyage explored such uncertainties as the quantity of submerged oil, and how the oil drifting northward changes with time and distance from the well site.

While the impact assessment and related research studies mark an important new direction in NOAA's participation in the Federal response to the Campeche spill, Frank explained that the team from NOAA and other scientific agencies will persist in its efforts to mitigate the impact of the drifting oil.

These efforts have brought some 80 of NOAA's scientists and technicians, spanning the full range of environmental science—oceanography, meteorology, fisheries biology, remote sensing, and related technologies—to a command center at Corpus Christi.

Experts to Assess Saving Monitor Parts

A panel of experts will be convened to determine whether historically significant parts of the Civil War ironclad, USS Monitor, can be raised without damage, Richard A. Frank, NOAA Administrator, has announced.

The Monitor lies in 210 feet of water 16 miles off Cape Hatteras. Frank revealed that a month-long archaeological investigation of the famed "cheesebox on a raft," has produced a wealth of information about the condition of the wreck "to evaluate further exploration of it, and perhaps the salvaging of some portion of the ship.

The Administrator ruled out any possibility of raising the ship in its entirety. "We will not risk shattering the remains in such an effort," he said. "Nevertheless we will determine whether...certain items of historical significance might be saved for all Americans to view."

Once a determination is made on what can be brought up, Frank said, "a decision must be made as to whether the expense, which will be substantial, is warranted."

His evaluation of possible future activities on the Monitor came when results of the expedition were presented to the public at a press conference August 29.

Divers from the North Carolina Division of Archives and History and from Harbor Branch Foundation of Ft. Pierce, Florida, found the ship in fragile condition, Frank said.

"Most of the vessel's upside-down hull has collapsed inward," Frank said investigation by divers revealed. "Many of its iron frames are weakened or badly distorted. The wreck's hull plating, where it is still attached, is thin, deteriorated, and delicate," he reported.

During the four-week investigation, divers recovered a number of artifacts from the wreckage, including such diverse objects as a seven-foot-long boat davit, an iron thimble, a number of bottles apparently from the officers' mess, a porcelain soap dish from the captain's cabin, a whole English walnut, remains of leather bookbinding, and pieces of mahogany woodwork from the captain's cabin.

Of special interest was the base of a brass lantern also recovered during the August dives. First thought to be a depth charge detonator, its true identity was revealed only after cleaning by a North Carolina conservator.

The artifacts, Frank said, will be made available for public display, probably within three years' time. Until then, adequate protective steps for them must be devised.

Underwater Pollution Detector Passes Tests

A unique system for detecting pollutants on the seafloor has been successfully tested.

Being developed under contract by Dr. John E. Noakes, Director of the University of Georgia's Center for Applied Isotope Studies, the system has two main components; a sediment agitator on an underwater "sled," and specimen processing equipment on the deck of a vessel.

The sled, towed beneath the vessel, skims along the bottom, taking sediment samples at timed intervals. The samples are pumped topside through a hose where they automatically are prepared for immediate X-ray fluorescence analysis.

"The system should prove invaluable for measuring the bottom concentrations of heavy metals in bays or estuaries and along the continental shelf," Steven Anastasion, Director of the agency's Office of Ocean Engineering, said. "It can be used both for early warning, if problem pollutants are found whose presence has not previously been suspected, and as a historical record of change in sediments over time."

Because of the close correlation between surface sediment samples and the chemical composition of seafloor sediments, the system also has potential for use in preliminary mineral assays.

Hurricane Camille Hit the U.S. Ten Years Ago

All that remained of a motel in Gulfport, Miss., after Camille struck, was the swimming pool. About 250 people in a five-state area lost their lives.

Ten years ago August 17, one of the most vicious hurricanes in the recorded history of the North Atlantic roared out of the Gulf of Mexico east of New Orleans, beginning a three-day battering of Louisiana, Mississippi, Tennessee, Kentucky, and Virginia.

By the time remnants of Hurricane Camille moved into the Atlantic off Virginia, its winds, storm surge, and rainfall had killed some 250 persons and caused damage in excess of $1 billion.

Camille packed a triple threat; 190-miles-an-hour winds at the time of landfall, a 20 to 25-foot storm surge topped by 15-foot breaking waves, and torrential rains that caused deadly flash flooding in Virginia.

Ample advance warning was given regarding where Camille would come ashore; warning almost the equal of that available today through improved storm tracking technology.

But warning of an impending hurricane is only half the story of survival, according to Richard A. Frank, NOAA Administrator. The other half is being able to respond quickly and effectively.

Too many coastal cities, he implies, even today are ill prepared for an adequate response to such a major assault, and accordingly risk the lives of residents and visitors.

"Camille could be the forerunner of a hurricane even more devastating to our increasingly populous coastal areas. Every city in every state along the Gulf and Atlantic should be prepared to meet a Camille."

NOAA is doing its utmost to encourage preparedness and assist communities in developing programs. Storm evacuation maps have been prepared, aiding local officials in developing their plans, including evacuation routes, areas, and shelters. Storm surge models are being developed that will enable planners to determine the surge effects in complex coastal bays and estuaries from model hurricanes. Research is underway to improve prediction of hurricane rainfall, the storm's major threat after it moves inland.

Connolly Is Executive Director of NACOA

John W. Connolly, for 15 years a senior official with NOAA, was named Executive Director of the National Advisory Committee on Oceans and Atmosphere (NACOA).

NACOA, which oversees the Nation's air and sea programs, consists of 18 non-Federal members appointed by the President from state and local governments, industry, science, and other areas. It was established by Public Law 95-63 on July 5, 1977 with the following duties:

- To undertake a continuing review, on a selective basis, of national ocean policy, coastal zone management, and the status of the marine and atmospheric science and service programs of the United States;
- To advise the Secretary of Commerce with respect to the carrying out of the programs administered by NOAA; and,
- To submit an annual report to the President and the Congress setting forth an assessment, on a selective basis, of the status of the Nation's marine and atmospheric activities, and submit such other reports as may from time to time be requested by the President or Congress.

Georgia Withdraws From CZM Program

Georgia became the first state to withdraw from the Federally supported coastal zone management program, in spite of what was termed the state's "impressive earlier history of natural resource management," according to Robert W. Knecht, head of NOAA's Coastal Zone Management Office.

"Although Georgia had a good set of State laws upon which to build an approvable coastal program," Knecht said, "it could not overcome strong resistance within its own State agencies to meet the requirements for improved and more predictable coastal management decisions, even after five years of development."

"This office has no insurmountable quarrel with the substance of Georgia's program," Knecht said. "The path to an approvable coastal program has been clearly laid out by the Georgia legislature, which authorized the Coastal Management Board to set coastal policy for the State. That policy has been set by the Board effectively, and we agree with it.'

The problem, according to Knecht, is within the State government, where there are agencies unwilling to agree to enforce these policies under Georgia law. Without such assurances, Knecht added, the State's program is not enforceable and cannot be Federally approved.

NOAA Establishes New Marine Pollution Program

Pollution in the oceans is the focus of a new program office established by NOAA.

Richard A. Frank, Administrator, said the National Marine Pollution Program Office will work with other Federal agencies to identify national needs and problems in ocean pollution research, development, and monitoring; recommend priorities for meeting the needs and problems; and, prepare plans to accomplish this.

Dr. Dail W. Brown has been named acting director of the Office. He previously headed NOAA's Office of Resource Use Coordination and Assement in OCZM.

Lawrence Heads Office of Administration

Samuel A. Lawrence

Samuel A. Lawrence, formerly Vice President for Financial and Planning Services at Cornell University and for two years Executive Director of the Stratton Commission, was named NOAA's Assistant Administrator for Administration.

The Stratton Commission, officially known as the President's Commission on Marine Science, Engineering, and Resources, was instrumental in developing recommendations which resulted in the creation of NOAA in 1970. Lawrence served as Executive Director of the Commission from 1967 to 1969.

A native of Providence, R.I., Lawrence held a series of senior administrative posts at Cornell. He joined the university in 1970, after a one-year assignment with Aluminium of Canada during which he conducted a special survey of the international ocean freight industry.

From 1954 to 1967, Lawrence was a senior examiner and an assistant division chief with the U.S. Bureau of the Budget, and prior to that was with Van Norman Machine Tool Co., in Springfield, Mass., and the New York Citizens Budget Commission.

Lawrence received his B.A. in sociology from Harvard University, and his M.A. in public administration and Ph.D. in Political Science from the American University. He also attended Brookings Institution under a Federal Executive Fellowship in 1963 on leave from the Bureau of the Budget.

Infrared Device Tested As Oil Spill Detector

A sensitive infrared scanner which can "see" an oil spill in the dark was tested aboard a research jet this summer to determine its effectiveness in detecting oil thickness, extent, and type during various weather conditions.

Dr. Peter Kuhn, a NOAA scientist, believes the instrument could be an important tool during partly cloudy, foggy, or hazy weather for assessing damage from an oil spill.

During this summer's test flights, Kuhn, a meteorologist with the Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., flew the instrument aboard a NASA Lear jet over a small permanent oil slick in California's Santa Barbara Channel.

The device, which weighs about 80 pounds (37 kilograms), is equipped with a variety of infrared filters to cut through very thin cirrus clouds, pollution or haze, and very thin fog.

Mounted in the belly of the Lear jet, the radiometer is aimed straight downward and rotates a full 90 degrees from side to side as the infrared "eye" of the instrument senses the heat emitted by a swath of ocean several miles wide.

"The potential value of the infrared system lies in the difference in temperature between the ocean and the oil slick which the eye or camera cannot detect," Kuhn said. "Furthermore, thermal differences provide a much greater range of identification than the visible."

According to the NOAA scientist, the radiometer converts the heat-sensitive signals from the ocean surface into black and white or enhanced color visual maps. Various shades of gray or color hues are calibrated against different oil types, thicknesses, and temperatures to portray oil extent, possible thickness, type, and age.

"A volatile oil such as fuel oil number two can show colder temperatures than the surrounding ocean," Kuhn explained. "Other, less volatile, oils such as bunker C crude, show warmer temperatures than the surrounding ocean due to strong absorption from solar radiation. As the oil ages, the differences in temperature decrease; the oil gets thinner and closer to oceanic temperatures."

Kuhn and his colleagues tested the possibility of oil slick identification under a variety of sea state and atmospheric conditions.

Lippold Sworn in as Head of the Survey

R. Adm. Herbert R. Lippold, Jr., was sworn in as Director of the National Ocean Survey in August. He succeeds R. Adm. Allen L. Powell who retired August 1.

A NOAA Corps officer, Lippold became the 19th director of the agency which was founded as the Survey of the Coast in 1807 by Thomas Jefferson. It was renamed the National Ocean Survey in 1970 with the creation of NOAA.

Lippold was formerly associate director of the NOS Office of Fleet Operations which is responsible for management of the NOAA fleet of 25 ships.

During his 29-year career, Lippold was served as the director of NOAA's Pacific Marine Center, aboard eight of the agency's ships, and in command of three; and as chief of the Satellite Triangulation Division in which he played a key role in the establishment of a worldwide satellite triangulation network. Other assignments have taken him to Honolulu, Hawaii; Pt. Pleasant, W.Va.; the Arctic coast; and to various states with geodetic field parties. He also spent 1 year in the DOC Scientific and Technical Fellowship Program and

R. Adm. Herbert R. Lippold, Jr.

was assigned to the National Bureau of Standards.

Lippold received a bachelor of science degree from New England College, Henniker, N.H., in 1949. He was awarded a civil engineering degree in 1950 at the University of New Hampshire.

Bronze Medals Awarded To Four NOAA Employees

Bronze Medals, awarded by the Department of Commerce for extremely competent performance of official duties in the Department over a long period of time, were presented to the following four NOAA employees during January-June 1979:

N. Patrick Laird, ERL (posthumously)
Robert L. Charnell, ERL (posthumously)
Henry A. Meunier, NWS
Verna G. Mize, NOAA Corps

Williams Is Naval Deputy to NOAA

R. Adm. Ross N. Williams, previously assigned to the Office of the Secretary of Defense, was named Naval Deputy to the NOAA Administrator.

He serves concurrently on the staff of the Chief of Naval Operations as Director of the Naval Oceanography Division and as Oceanographer of the Navy.

A naval officer since 1951, when he was graduated from the U.S. Naval Academy, Williams completed postgraduate work in oceanography at the University of Washington, in Seattle, and attended several courses in nuclear power offered by the Navy.

During much of his career, Williams has served in submarines, commanding both the USS Benjamin Franklin and the USS Tecumseh. In November 1969 he was appointed Undersea Long Range Missile System Program Coordinator in the Office of the Chief of Naval Operations and from

R. Adm. Ross N. Williams

1970 to May 1973 was Head of the Trident Program Coordination Branch.

Returning to sea as commanding officer of the USS L.Y. Spear in June 1973, Williams was assigned as the Military Assistant to the Deputy Under Secretary of Defense Research and Engineering (Strategic and Space Systems) in June 1975.

He holds a number of awards and decorations, including the Legion of Merit with gold star.

300th Station on the Air

The Nation's 300th NOAA Weather Radio station (WXL-S7) went on the air in September in Columbia, Mo., providing continuous observation and forecast programming from the National Weather Service.

The Columbia transmitter was the latest in a 350-station network of NOAA Weather Radios slated to be in operation by the end of the year.

Dr. Richard A. Hallgren, Director of the National Weather Service, said NOAA Weather Radio program is proving to be one of the most popular services provided by the agency.

In addition to providing general weather information for the Columbia Fulton, Jefferson City area, the new NOAA Weather Radio station will give timely and accurate weather watch and warning messages when tornadoes, winter storms, or other severe weather threatens central Missouri. The information broadcast on the new station comes directly from the local National Weather Service Office at the Regional Airport on the NOAA Weather Radio VHF-FM frequency of 162.40 megahertz.

Oil Refineries in L.A. May Contribute to Rain

Oil refineries in smog-ridden Los Angeles may increase the tendency of polluted clouds to produce rain.

Materials released into the air by the refineries are believed to change the character of smog-polluted clouds, restoring their ability to produce rain, research conducted by NOAA indicates.

In a recent EPA-funded study of clouds sampled in smogless areas near Los Angeles, in smog-polluted areas over the city, and in the plume of effluents released by near-by oil refineries, the NOAA researchers found differences that "can be attributed directly to the effects of particles picked up by the clouds from refinery effluent."

Drs. Earl W. Barrett, Fran Parungo, and Rudolf F. Pueschel, all of NOAA's Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., reported that samples taken in unpolluted clouds contained relatively large cloud droplets. These clouds, if deep enough, would tend to produce rain by a coalescence process much earlier than would a cloud containing small droplets.

Samples from smog-polluted areas contained an excess of small droplets, leading the researchers to conclude that the urban smog inhibits the production of rain by the coalescence process.

But samples of clouds from the third area, where oil refineries were releasing effluents into the polluted air, showed that some constituent of the effluent caused an increase in large droplets, which served as effective condensation nuclei and offset the urban pollution.

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